The Welding Engineer

Founded by L. B. Mackenzie, 1916

MARCH, 1925 VOL. 10. No. 3

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. Reg. U. S. Pat. Office $4.00 per year abroad

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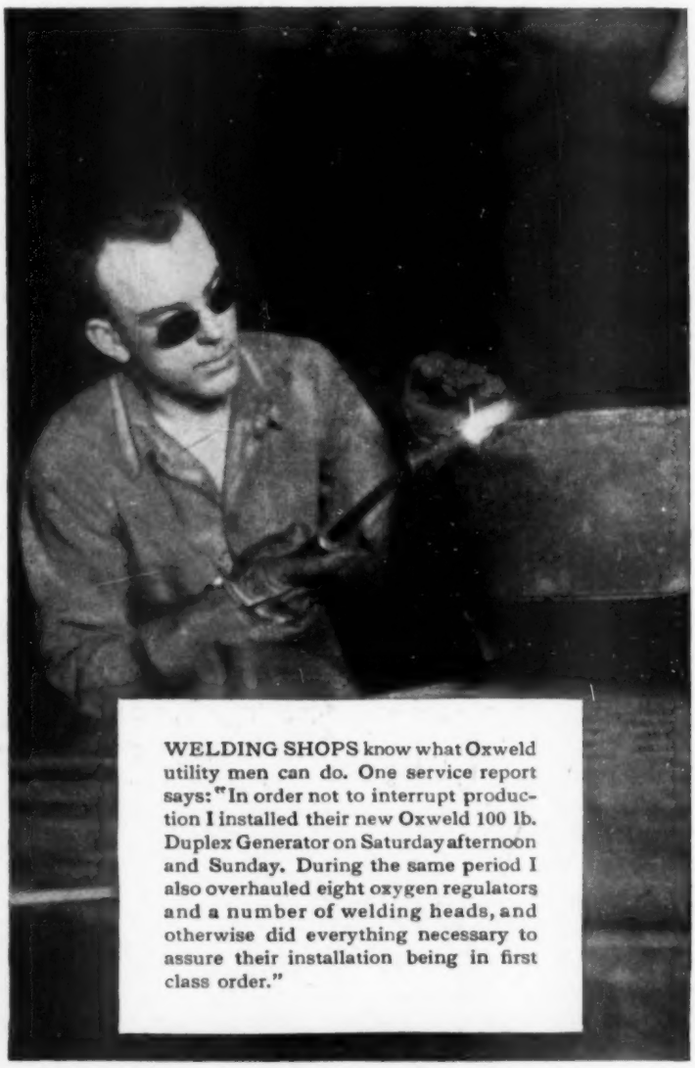
Why will you find our man in your plant?



WELDING SHOPS know what Oxweld utility men can do. One service report says: "In order not to interrupt production I installed their new Oxweld 100 lb. Duplex Generator on Saturday afternoon and Sunday. During the same period I also overhauled eight oxygen regulators and a number of welding heads, and otherwise did everything necessary to assure their installation being in first class order."

THE PURCHASE of Oxweld apparatus does not end with the delivery of the apparatus to you.

The Oxweld Acetylene Company considers it a part of its duty to help keep all Oxweld apparatus in proper condition and working efficiently.

It is also a part of Oxweld's duty to see that all Oxweld customers are informed of the best methods of welding and cutting, and that they are instructed in new processes discovered by the research laboratories.

The greater part of this obligation can be fulfilled only by personal visits to your plant. That is why some day you will find an Oxweld utility man in your plant.

He will be inspecting your apparatus, making minor repairs or adjustments, instructing or informing your operators on new methods, doing everything he can to help you obtain the fullest use of your Oxweld apparatus.

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WELDING AND CUTTING APPARATUS

WORLD'S LARGEST MANUFACTURERS OF WELDING AND CUTTING EQUIPMENT

When the Tail Wags the Dog

SOMETIMES the tail seems actually to wag the dog and here's a case in point—upside down welding where the awkward position of the welder's hand results in the torch actually wagging and fagging both torch and man.

But not so with Purox welding torches and cutting attachments, for the very good reason that the Purox gooseneck is attached to the torch handle by a union nut which permits adjustment of the tip position to suit the comfort and convenience of the welder.

This adaptability to work in awkward positions and inaccessible places is only one of the many Purox torch virtues.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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See "Torches"

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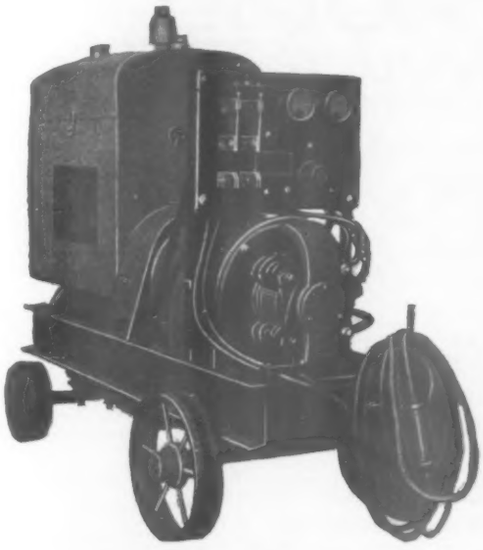
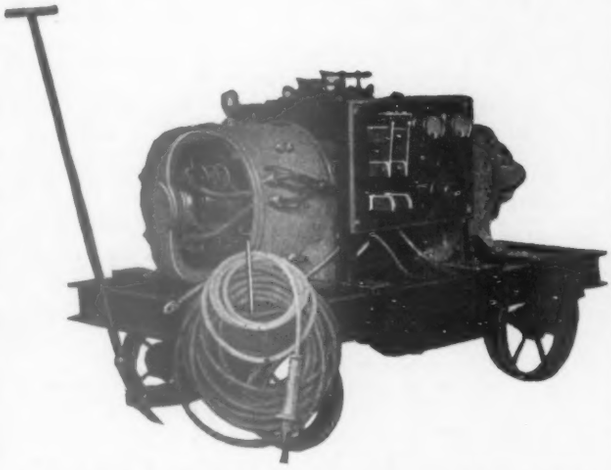


Single-operator Wilson "Plastic-Arc" gasoline-engine-driven welding machine, range for 75 to 200 amperes.



Single-operator Wilson "Plastic-Arc" motor-driven welding machine, range from 75 to 250 amperes.

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IN producing the New Type S Welding Machine, the Wilson company has advanced still further its leadership in the building of welding machines. Control of current fluctuations, which assures *constant* heat at the weld, is brought to its highest, and well-nigh perfect, point of efficiency in the New Wilson Type S. This control, combined with the ease with which the arc is *struck* and *held*, makes flawless welding the usual result with the Wilson Type S. Its sturdy construction and simplified panel reduces maintenance cost and lowers the cost of welding. Gasoline-engine-driven and electric-motor-driven—each a complete, self-contained unit. Send for descriptive literature.

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National Gauge and Equipment Co.
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Weldit Acetylene Co.

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Modern Engineering Co.
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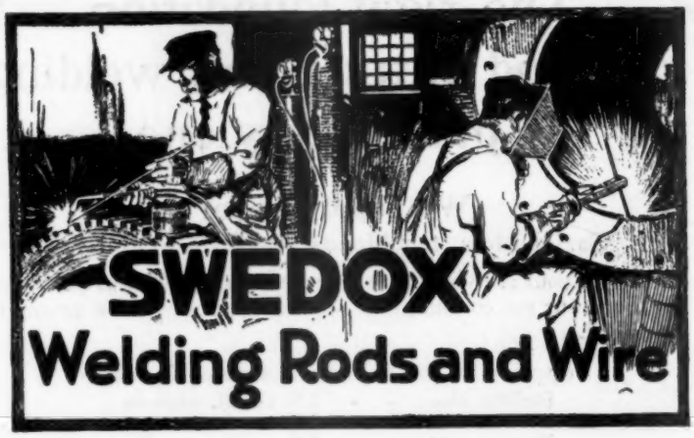

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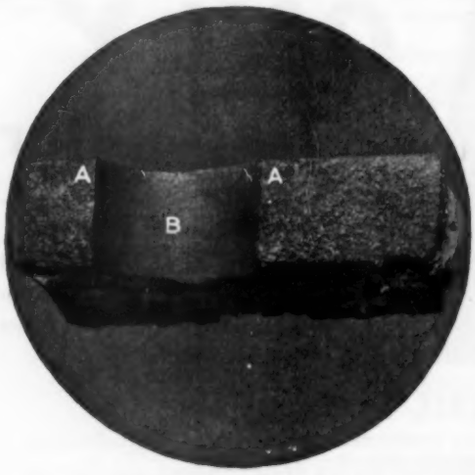

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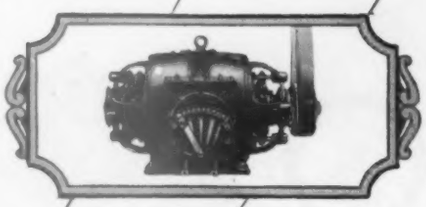

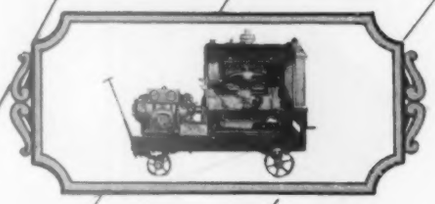

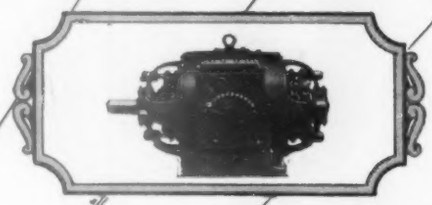

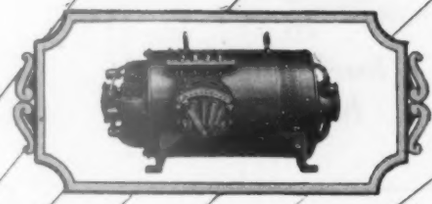

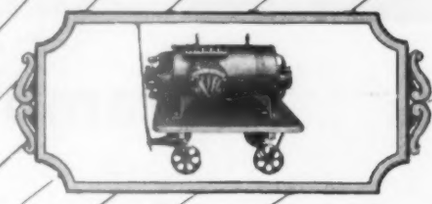

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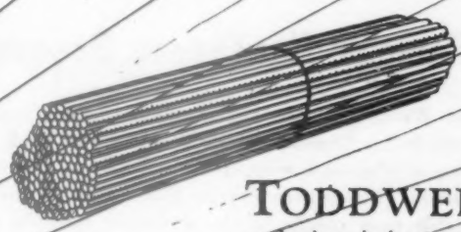

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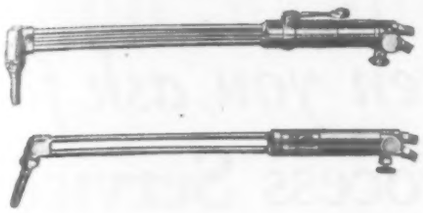

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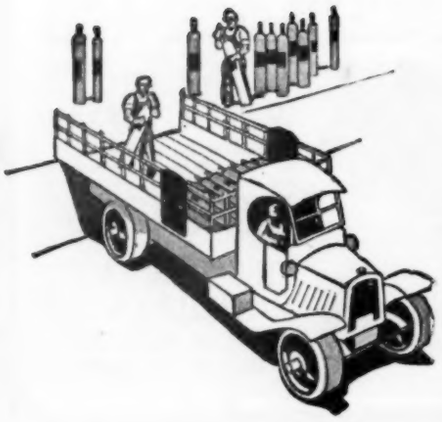

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Thermit Welding Locomotive Frames

How to Go About This Job—What Thermit Welding Is—Making the Mold—Preparing the Weld

By R. P. Palmer

I HAD just finished dinner and adjourned to the living-room, arranged my paper and writing equipment in a nice orderly manner, when the wife entered and demanded to know what I was going to do. I informed her that I was going to write a letter to *The Welding Engineer*. She said, "I don't believe I would bother if I were you for Shep will contradict you and call you a heathen." I told her not to worry as my feelings are not so easily hurt, and to try and think of something nice and mean to say about Shep so I could write it.

Well, now to get back to the beginning, what I wanted to tell you was about Frame Welding.

I was invited by a friend to a dinner and during the dinner, the conversation turned to welding. One fellow started to tell about welding frames by the electric process, when another interrupted and said that the thermit method was the only way to weld frames. The host said that acetylene was the best and requested that we wait and settle the question in his den. The line up was one for electric, one for thermit and two for acetylene.

Thermit got the high card, so he started by saying: First; Thermit is made from aluminum and iron oxide. The aluminum being ground in small particles about the size of a grain of salt, this we will call aluminum salt. Next is iron oxide. This is also ground fine. The particles being slightly larger than the aluminum. This is made from scale or oxide, which forms on a piece of iron. When the iron is heated, there are particles of iron that absorb the oxygen from the air and condense it. As the iron absorbs the oxygen, the oxygen acts upon the iron in this way.

The metal is hot and of course is expanded. The crystals have separated to a certain extent and the grains are enlarged. The oxygen gets in between the grain and forms a thin film causing the grains to become separated from the parent metal. When the parent metal cools and contracts the action causes the iron oxide to become loosened and fall off. You all know the value of oxygen for combustion, so you can see the value of this condensed oxygen or iron oxide in thermit welding.

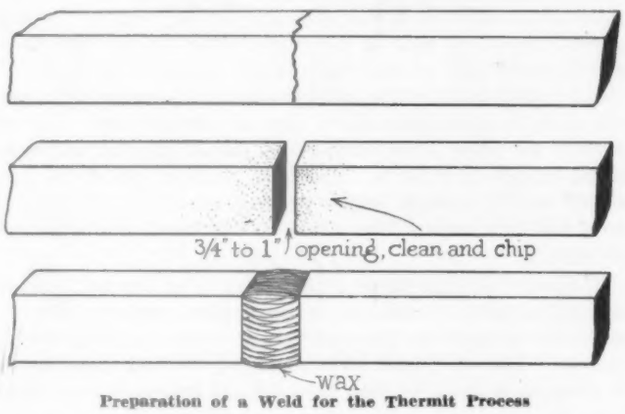
The next thing is to get adding metal. This is in the form of plugs that are punched out of a sheet of low carbon steel. These plugs are of various sizes. The largest is about ¼" thick and has a diameter of ⅜". This is what forms the body of a weld or might be called adding metal. Then to give a little extra strength a small amount of nickel is added. The nickel is in pieces about ¼" to ½" of irregular shapes and is bright and shiny. I always compare nickel in thermit to salt in soup because it could be made without it but would not be quite so good.

Now that we have the concoction all ready, we will proceed with the actual welding of a locomotive frame. The first thing to do is tram your frame. Then, be sure that all parts of the locomotive that might interfere with the work are removed. Then the next step is to spread the frame giving it about the same amount of opening as for acetylene. (A 4" x 4" should have at least ¼").

A cutting torch is used to cut a piece out of the frame, ¾" x 4"-x 4", after cutting with the torch, both ends of the frame are clipped to insure a clean surface.

The space where we cut the ¾" x4" x4" piece out of the frame with bees' wax is then filled. Leaving the wax extend 1" on each end of the frame that is to be welded; also allowing it to extend on all four sides of each end. The wax should be slightly thicker in the center of the space between both ends; in other words if measured through the center the thickness of the wax should be 5", one-half inch reinforced on each side. This should be trimmed to the size of the frame, 1⅜" from the center of the weld, making a collar 2¾" wide.

A box is now made in which sand is packed around the weld carefully, so as not to scar the wax, as the finished weld will look just like the wax used to make the pattern. We use facing sand next to the wax which will stand a very high heat, also, a less expensive molding sand for the backing up sand or body of the mold.



Preparation of a Weld for the Thermit Process

There is always at least 4" of sand all around the wax as any less is liable to burn out, or crack in drying and allow the molten metal to escape.

It has been found that the best way to make the box in which we place the sand is to weld by the electric method. This is much quicker than the old way of fastening the box together with bolts and is also less difficult. When building a box in a bad place, we tack the sheets together, welding a spot ½" long. About every 4" the weld is severed with a cutting torch. When we remove the box no damage is done to the sheet which we use for dozens of welds.

After the mold is complete, we usually allow it to stand over night, which helps dry it.

The sand is dampened just enough so that when you pick up a hand full and press it, it will retain its shape when the hand is opened.

Before leaving the mold for the night or before beginning to heat, if not left over night, we take a ⅛" rod and fill the sand full of vents, making one hole to each square inch of surface on top of the mold; within a radius of two inches of the riser, being sure that the rod goes through the sand and touches the wax.

For all surface out side of 2", we use $\frac{3}{16}$" x ¼" rod, making one hole to each square inch. We cut a ¼" hole in the back and side sheets to every four square inches. Sometimes it is impossible to cut holes in side sheets, but we always cut them in the back sheets. Don't cut holes below 4" from top of sand, in side and back sheets.

Then we take a $\frac{3}{16}$" x ¼" rod and make a vent for every hole that we cut in the sheet, making sure that the rod touches the wax. Now that there are sufficient vents, one need not worry about having holes in the weld.

We start heating by using a very little air and oil and after lighting the torch, we heat a ¼" rod red hot and stick it in the wax, through the riser hole at the top, also through the pouring gate hole thus allowing the heat to pass through the wax, causing it to melt quickly. The flame is kept small for the first hour, which allows the mold to dry thoroughly. A large flame is then used but a 4" x 4" frame should not be heated a cherry red in less than three hours, if good results are expected.

If the mold is not entirely dry when the weld is made, there are sure to be holes in the weld because the intense heat of the thermit will start to dry the mold. The steam thus formed will start to pass off through the molten-metal and will become entrapped as the metal nears the surface, which will make a crust on it and the result will be a weak porous weld.

Before placing the thermit in the crucible, always take the boxes that the thermit is packed in and build a small fire in the crucible, at least one-half hour before using. This expands the material that the crucible is made of and no trouble will be caused by same cracking after the powder has been lighted. Twenty-five pounds of prepared thermit is allowed for each pound of wax used in patterns.

We always empty the amount of prepared thermit that we intend using in a steel wheel barrow and mix the entire amount thoroughly together, before placing it in the crucible. We get a good cherry red heat on the frame before lighting the thermit and it should take at least three hours to secure this heat. The chain used to hold up the crucible should be covered with asbestos cloth, a paste made of fire clay or asbestos dust. This will prevent the chain from burning off, should some of the molten metal happen to strike it. The block used to spread the frame should not be removed within two and one-half hours after the weld has been made. This will allow the metal to solidify completely.

The main point in favor is that there is no job too large and the entire weld is made at the same time, therefore all of it starts to contract at the same time, which avoids locked up stresses within the metal. The metal will be free from porosity if attention is given the vent holes and the heating is done slowly.

As the electric comes next and he had a lot to say I will wait until a later date to describe his methods.

(Watch for the next article by Mr. Palmer. It will appear in an early issue.)

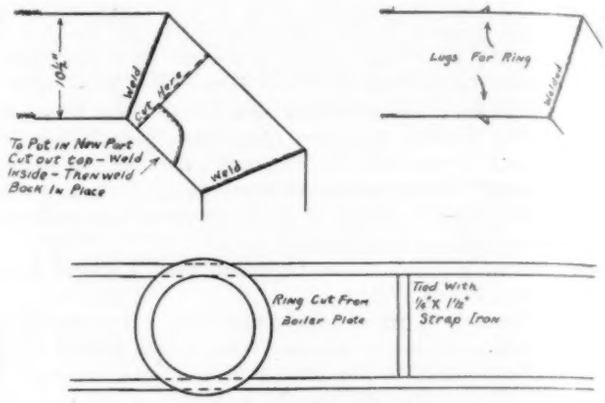
ODD JOBS OF THE WELDER
By Geo. E. Strong, Ventura, Calif.

I have had two jobs that might be of interest to some of the boys. An exhaust pipe casting broke causing the thread on the pipe to rust out, necessitating the renewing of both. The pipe set back in a concrete recess with very little play on either side. I reached in with a cutting torch and cut the pipe off just below the 45 degree, then broke the casting the rest of the way with a hammer.

Getting the new stub back proved to be the big problem. There wasn't room to hold it in place with my hands and get it started in the new casting on account of the concrete projecting out so far. The casting rests on the outer part of the engine base which has a hole cut in it to allow the pipe to go through. I welded a short 45 degree on the thread stub, then cut a ring out of a boiler plate and put it over the pipe from the top. I then welded four lugs made from ¼-inch welding rod above the ring so that when I got the pipe in place the ring would be stationary and the lugs would slide around. In order to hold the pipe in place I took two pieces of 1-inch pipe and tied them together with a strap of iron, using a block of wood for a heel to ply the stub in place. By raising or lowering either handle I could build the stub any way desired. My helper reached in, turning the stub and in a very few minutes we had it tightened. To get the pipe welded together again I cut out the top and welded around the inside until I could reach it handily from the outside. I then welded the top back again, completing the job in 7½ hours, which had a schedule of 12 hours before.

Job No. 2 was that of welding a 4-inch intake line from the compressor inside the plant to a pipe on the outside of the building. It had to go through the side of the sheet iron building near the roof.

Being allowed to cut a hole no larger than necessary to let the pipe through I had no way of getting an exact measurement, as the pipe had to go through with a 45 degree near the wall. I tried to cut and fit a pipe more or less by guess, but it did not work,



How New Stub Was Put In

so I took a thin board, 4½ inches wide, and cut the end out in the same contour as the 8-inch pipe and held it at the side of the 45 degree angle on the 4 inches and marked the exact angle. I then put my template on the short piece of pipe marked and cut in and the fit was perfect. I have used the board for several angles since and find it a very quick and easy way to get angles on any size pipe where both ends are stationary.

W. F. BARRETT RECEIVES DEGREE OF DOCTOR OF SCIENCE

Mr. W. F. Barrett, vice-president of The Linde Air Products Company, has recently been conferred the degree, Doctor of Science, by the University of Pittsburgh. Mr. Barrett has a very keen appreciation of the value of science applied to industry and in addition to the specialized physical problems connected with the production of oxygen from liquid air, Mr. Barrett is prominently identified with the Carbide and Carbon Chemicals Corporation, which produces organic solvents, intermediates, refrigerants and anaesthetics. This corporation is a newly organized subsidiary of the Union Carbide and Carbon Corporation. Mr. Barrett is also very interested in the Union Carbide and Carbon Research Laboratories, Inc.

ECONOMY WELDING MACHINE COMPANY ISSUE NEW CATALOG

The Economy Welding Machine Company, of Kansas City, Missouri, have recently distributed a new catalog describing their line of welding equipment which includes outfits, torches, regulators, generators, accessories and other welding supplies. The booklet is very attractively made up and consists of thirty-six pages and a heavy gray paper cover. It is profusely illustrated.

PLUMLEY BACK ON THE JOB

Mr. Stuart Plumley, Editor of the Acetylene Journal, recently returned to his desk after a long and severe illness which made it necessary for him to spend several weeks on the Southern Coast. His many friends in the welding industry will be glad to learn that he is enjoying good health and the industry itself will benefit from a continuance of the good work he has been doing, not only as a publisher in the oxy-acetylene welding field, but also as an active worker for the progress of several of the associations which serve the industry.

Making Difficult Welds

Ingenuity Solves Many Problems in Welding for the Power Engineer—Welding in Hard Places—Success Means Sticking to It

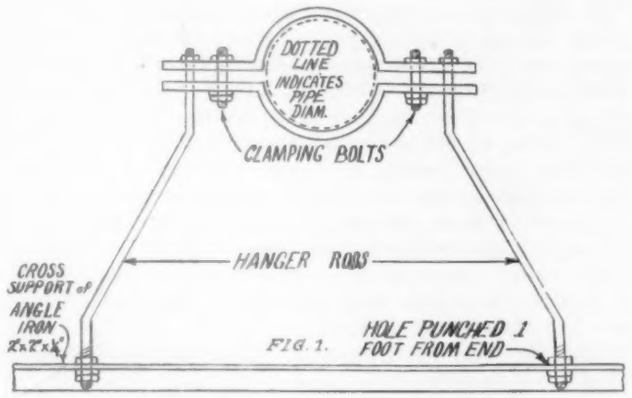
By George F. Walker

ONE of the most interesting jobs that I have worked on was out at the Beverly Gas and Electric Company, Beverly, Massachusetts. Here we did some out of the ordinary welding on a steam job where both high and low pressure had to be taken into consideration. It consisted of welding two and one-half inch extra heavy six inch, eight, and ten inch pipe. These were for both high and low pressure steam and in addition to this straight pipe welding it was also necessary to weld in flanges, nozzles, and a number of two inch couplings. These were placed at various sections of the line as pick ups and drips.

The first weld was on an eight inch line. This was outside and the work had to be done in weather about ten degrees above zero. A staging was erected on which to work and when you were up on it the wind seemed to be dashing along about forty miles an hour. You see the work was located on a water front and there was no protection from the wind and cold, so the working conditions were not very favorable. In fact, we judged that about three times as much time and stock was used on this job as would ordinarily be used under more favorable conditions.

Inside of the gas machine building we made six welds on lengths of eight inch pipe and in addition made four welds on eight inch nozzles and two two-inch couplings. In doing this work we encountered more difficulties for the pipe lines were located about twenty feet high and very close to the wall. It was necessary to build stagings and this work was hampered by the great number of machines scattered about the floor. Ladders and planks were about the only things available and none too steady. The pipe of course had to be slung in hangers and pitched before welding. The hangers were suspended from the roof of the building and it was quite a problem to keep the pipe in alignment, this was important during welding as the alignment then had to be perfect. This was overcome by making pipe clamps out of 4 inch by ½ inch bar iron and clamping the joints ahead about three at a time. This proved to be satisfactory and no more difficulty was experienced from this source.

After leaving the gas machine building the eight inch pipe picked up to a ten inch line. This line ran to the second story and all of the pipe was welded in place. It was against orders to have a light in or around the building so I was not able to open the window and sit on the ledge during welding. I therefore had to execute the welds from a ladder which proved to be a very tiresome position from which to work. When all the lines were welded it was necessary to weld in a lot of eight inch nozzles. These were inserted at various places where the necessary branching off places were located. The cutting torch was used for this purpose as we were welding with the oxy-acetylene process. The hole was cut out, beveled and fitted with the torch. In order to do this work in the easiest manner I designed a portable staging which is illustrated in the sketch. These could be used and when the weld was completed easily moved to the next one with only the aid of a helper. The



How Pipe Hanger Platform Rack Is Made

stage hangers and supports consisted of four pieces of ⅞ inch round iron, five feet long and offset at each end and bent out at an angle so as to allow about five or six feet between hanger rods. In addition there were two angle irons eight feet long and two inches by two inches by ¼ inch in width and thickness respectively. Of course the length of these angle irons can vary according to conditions. An inch hole was punched at each end about a foot from the end. Two sets of pipe hanger clamps were made of ½ inch by four inch bar iron and bent around the size of the pipe. Each radius was allowed to be an half inch short to allow for clamping tight.

These clamps and hangers can be placed anywhere on the pipe, we usually spaced them about ten or twelve feet apart and then laid planks from one to the other making an ideal working platform. The planks ran the same way as the pipe on which the hanger was clamped. It gave us about three and one-half

Left—Two-Branch Header 8"x8"x8"x6'. Center—Welding 8" Nozzle on 8" Line. Right—10" Line All Welded in Position

feet clearance underneath the pipe, and free movement on both sides of the pipe.

This company had experienced previous trouble with warping and leaking flanges and were concerned about the ability of welding to overcome this trouble. In order to do away with this I bolted a cast iron flange to the face of the steel flange. When these flanges were made up and tested they showed no leaks and therefore no warping. In the stock room there were a number of ten inch joints to weld. These were located only a foot from the ceiling. Here we met another problem as the ceiling was studded with sprinkler heads and it was necessary to cover each one, in the vicinity of the welding, with a piece of cotton waste soaked in water. If we didn't do this we were liable to set them off.

Thanks to the cutting and welding torch we were able to use a number of bends which were sent out to the job and were either too long or too short. This of course saved a lot of time.

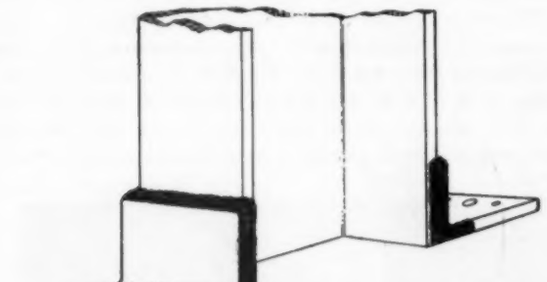
The high pressure lines were welded in the boiler room right up over the boilers and all the time that we were welding we encountered high temperatures as the pressure was constantly held at about 140 pounds. However the work was completed and no leaks were found.

As a closing thought I would advise any welder who contemplates welding for power engineers to learn how to weld with either hand. This is almost necessary on account of the difficult positions in which the welding must be done and also because it allows one to relieve the strain which develops in the welding arm. The welding we did on this job was very trying to our patience, but when it was finished we had a great deal of satisfaction in knowing that we had accomplished something worth while. To the power engineers and pipe companies I would suggest that one of the best investments they can make is to get a welding outfit and a skilled operator. With these two, they will be able to make many worthwhile savings in time and money for the operator can make bends right on the job with mitred sections and he can also weld joints, cut pipe and make himself a valuable asset to his employer.

WELDING SOLVES ANOTHER PROBLEM

By R. K. Randall*

The machine shop conducted by the Cleveland School of Technology recently moved from their old quarters to new ones. In the old shop, the lathes, planers, automatic screw machines, shapers, grinders and drill presses were run by two large motors connected with countershafts. The new quarters made the use of countershafts inadvisable so it was decided to equip each machine with a motor of its own. This made it possible of course to operate each machine at any desired speed and also to run one or all machines as the occasion demanded.



These clips welded to channel irons, then bolted to concrete blocks.

Details of Welded Uprights

The school maintains a fine welding shop equipped with standard makes of oxy-acetylene and electric welding and cutting apparatus. This made it possible to solve the problem of mounting the motors.

The first step in the job was to make uprights. For this, 4" by 8" by 4" channel iron was used. To the ends of these were welded, one on each side, 6" by 6" angles to be used as clips. These clips were cut to size by the oxy-acetylene cutting torch and then electrically welded to the channel. A hole was then burned in the clip to allow bolts which set in cement to pass through, thus securing it at the bottom.

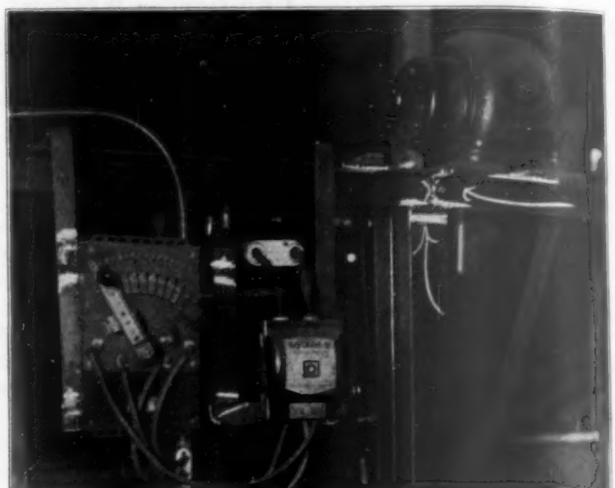


Fig. 1. Motor Supports Electrically Welded

The columns were spaced 7 feet from center to center. For the top ordinary 3" by 3" angle iron was used. Through the ends of these angles ½" holes were burned with the oxy-acetylene torch and then help up in place and the channels marked for holes. Then these channels in turn were pierced. The angles were then bolted to the upright and electirc welded in place, a heavy weld being made to insure strength to withstand the vibration. On illustration 1, the welds holding top angle iron to upright channels are shown.

Fig. 2. Completed Installation

It was also necessary to make provision for mounting the switch boxes and the variable speed control boxes. The welding department made quick work of this by bending flat 1½" by ¼" stock to proper size and then welding in cross pieces. These hangars were then welded to top of angle iron to hold them.

A good idea of the general neatness of this installation is given by looking at illustration 2. The "superstructure" as we call it supports 15 motors and even when all machines are pulling, the structure is as rigid as can be. It is interesting to note that this entire installation was made without the aid of any tools whatso-ever except the oxy-acetylene cutting torch and the electric arc welding machine.

Welding Instructor, Cleveland School of Technology.

Fabricating Large Structures*

Joints Specially Designed for Welding—Detailed Account of Them and a Comparison of Welded and Riveted Trusses

By H. Goldmark†, W. Spraragen††, and W. L. Warner†††

PART III

UP to the present time most welded structures have not been carefully proportioned with proper regard for stresses to be carried and the strength of the parts necessary to carry them. Little is known of safe methods of design for steel structures although there are several instances where steel works have been erected without rivets, the joints having been put together by welding. In most cases this work has been done by designing a structure for riveting and then welding the joints wherever possible with the electric arc. In this manner welded structures have been built which are considerably heavier and stronger than is necessary to carry the required loading.

Fig. 8—Model of Ewertz Type of Electric Arc Welded Vessel Carrying 400 Percent Overload

In a report to the American Bureau of Welding covering the "Application of Arc Welding to Ship Construction," Mr. E. H. Ewertz states that it is his belief that substituting welding for rivets in a structure designed for using either method is wrong as a basic principle. The results derived from welding in such a method are at least partially defeated. All of the structural shapes such an angle bars, tee bars, zee bars, etc., were designed primarily for convenience in riveting. One flange of an angle bar is used simply as a means of fastening the other flange in its proper position. It is only the outstanding flange that gives stiffness and strength to the plate construction and the flange used for fastening by rivets is valuable only for furnishing the place for the rivets and does not add to the strength of the structure.

With this in mind, Mr. Ewertz designed an arc welded ship in which all flanges needed in the riveted structure for fastening are omitted and in place of angles or other shapes, plates or flat bars are used. To produce reinforcement in many places, flanged plates are used, but in such cases the flanges on the plate performs the service of a stiffener. (See Fig. 8.)

Another important item which the structural engineer who considers welding for fabricating should have in mind is the design of parts in such a way that most of the welding can be performed in the shop and overhead welding eliminated as much as possible.

Mr. Ewertz goes on further to state that in a ship designed for all electric welding, estimates show a saving in weight of structural steel material of over 25 per cent as compared with a similar design for a riveted ship. The hours of labor for hull construction showed a reduction of over 20 per cent. Modified designs or designs where either riveting or welding can be used while they clearly indicate a saving, show a saving that is naturally proportonately lower to that obtained in a ship designed for all electric welding.

These same fundamental facts were recognized by the General Boiler Co. in the construction of their factory building.

In Appendix "B" one of the authors (Mr. W. L. Warner) compares in detail a diveted truss with one where welding has been substituted.

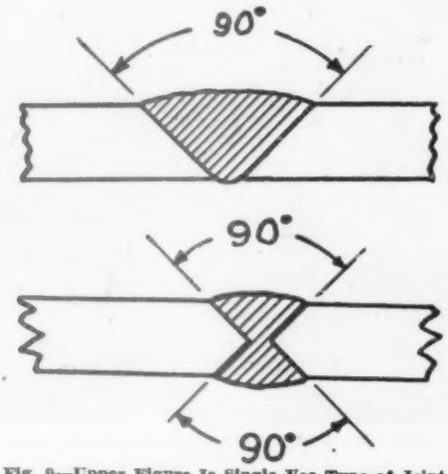


Fig. 9—Upper Figure Is Single Vee Type of Joint. Lower Figure is Double Vee Type

The structural engineer is inclined to look with suspicion on a single weld which carries enormous loads and where failure might result in damage to life or property. While he knows that riveting is not altogether a safe proposition as indicated elsewhere in this report, nevertheless he feels that because there are so many of them that even if 15 per cent were bad the structure would still be safe because of the factor of safety employed in the design.

These engineers feel, moreover, that while some welded parts are equal to the strength of the original material, nevertheless it is imposible in some instances to detect a bad weld which may have only 50 per cent of the strength of the original material. Of course the welding experts will argue that the

*Presented at the Fall Meeting, A. W. S., Cleveland, Oct., 1924.

†Consulting Engineer.

††Secretary, American Bureau of Welding.

†††Industrial Engineering Department, General Electric Co.

solution is proper welding inspection and this subject is treated elsewhere. However, if possible welding parts should be so designed that there will be a large number of small welds to carry the load instead of one large weld. The same arguments would then hold true as in the case of riveting.

In the past the structural engineers who were not familiar with welding have been inclined to take the cross sectional area of a weld and allow so many pounds per square inch as the tensile strength or shearing stress of this particular weld. There are many important variables which make such a procedure dangerous, such as for example design of joint, chemical composition of parts to be welded, type of electrode used. This can be best illustrated by comparing the two simple types of joints shown in Fig. 9. In one figure there is shown a single vee double beveled joint; in the other a double vee double beveled joint. The cross section of deposited weld metal is the

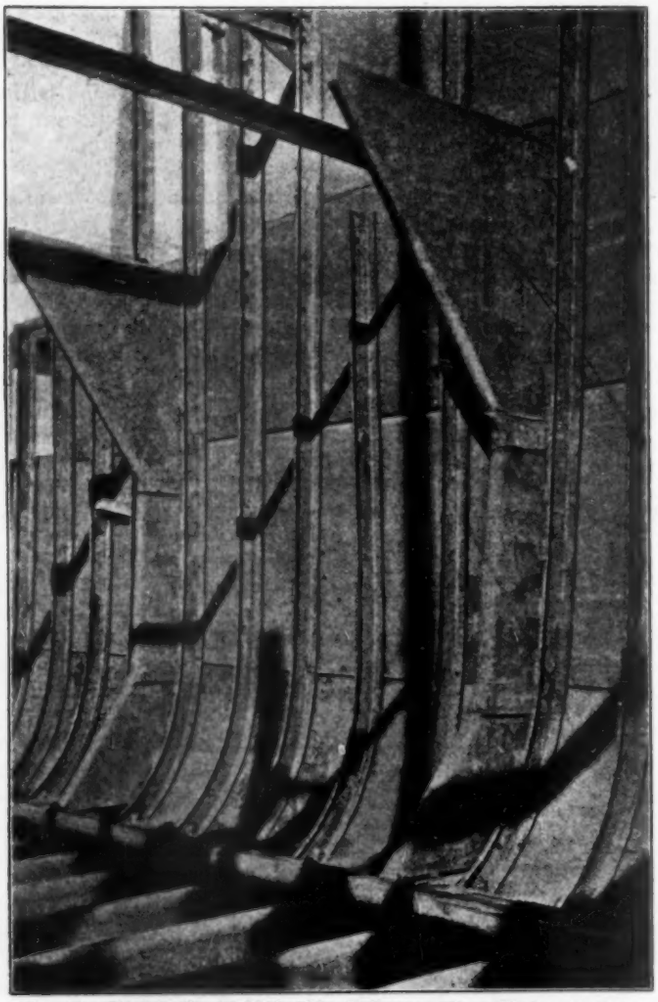


Fig. 10—Electrically Welded Ship Fullagar, Floor Plates, Frames and Plating

same and yet a number of tests in structures such as tanks have shown that the double vee joint is from 25 to 50 per cent stronger than the single vee joint. This difference can be ascribed to the fact that (1) it is harder to make a thoroughly sound fused joint with the single vee type, particular at the bottom of the vee and (2) that because of the unsymmetrical section of the single vee a bending strain is thrown on the deposited metal (it must be remembered that the deposited metal has different physical characteristics from the original base metal). From an economical viewpoint it so happens that it costs less to make a double vee than it does a single vee joint.

It should also be remembered that the physical properties of the deposited metal depend not only upon the type of electrode used but also on the physical and chemical properties of the base metal.

Another important factor which must be taken into account is the fact that in some instances joints designed for riveting do not make it possible to secure good welding. Factors such as position of welding, heat conductivity of the edges to be joined, etc., are some of the reasons that may be cited.

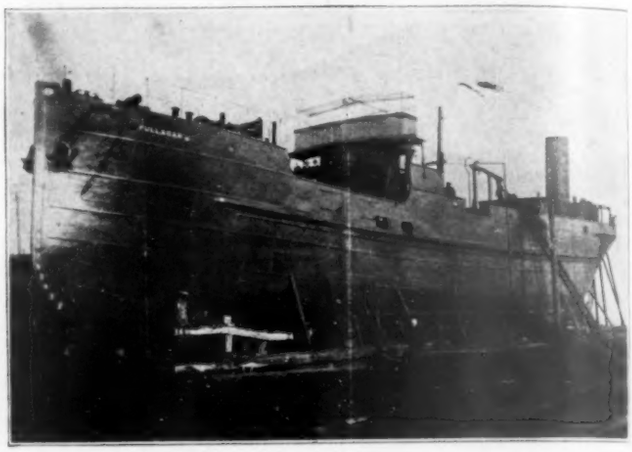


Fig. 11—Electrically Welded Coaster Fullagar Built by Commell Laird and Co. Ltd., Birkenhead, Using Flux Covered Electrodes

Large office buildings are usually of a steel cage type. This type of construction lends itself particularly to welding as the safety of a building does not depend upon any single weld.

Appendix B

Welded Truss

W. L. Warner†

THE design of a welded truss is a relatively simple matter when the style of the truss and the loading are known. At the present time, however, so little is known concerning the strength of various types of structural welds that the complete design of a steel structure is out of the question. In Fig. 24 is shown a small riveted truss which was designed for a span of 48 ft. for railway service. It is the author's purpose now to redesign this truss for welding. It should be borne in mind, however, that the greatest economy will result only when the truss or structure is designed for welding in the first place instead of designing it for riveting and then redesigning for welding. This point will be explained in the discussion.

In the various steps of the design which follow the safe loads for various sizes of bead are those given by Prof. F. P. McKibben in his paper, "Arc Welding of Steel Structures." These are as follows:

¼ in. by ¼ in. bead	1593 lb. per linear inch
⅜ in. by ⅜ in. bead	2394 lb. per linear inch
7/16 in. by 7/16 in. bead	2781 lb. per linear inch
½ in. by ½ in. bead	3195 lb. per linear inch
9/16 in. by 9/16 in. bead	4770 lb. per linear inch

NOTE: The above values are based upon the results of tests which gave the average shearing strength of welded beads as 36,310 lb. per square inch. Allowing a factor of safety of 4, the safe allowable stress is 900 lb. per square inch.

End Connecting Angles (A)

These members consist of two angles 6 in. by 6 in. by ½ in. each, with 24 rivet holes, and are connected by 16 shop rivets to the ⅝-in. gusset plate (c). The safe load which these angles can carry is limited by the shearing section A shown in Fig. 25, Sketch I, or by the strength of the 16 rivets shown at joint No. 1 of the riveted truss.

†*Industrial Engineering Department, General Electric Co.*

The net section through one line of 8 rivets of angles A is equal to the total length, about 26 in. minus the width of 8 rivet holes multiplied by the thickness of one angle, and this figure multiplied by two for the two angles. This gives the distance A in Sketch I as 18 in. to give the same shearing strength for the two welded angles as for the riveted angles. We must now consider the weld.

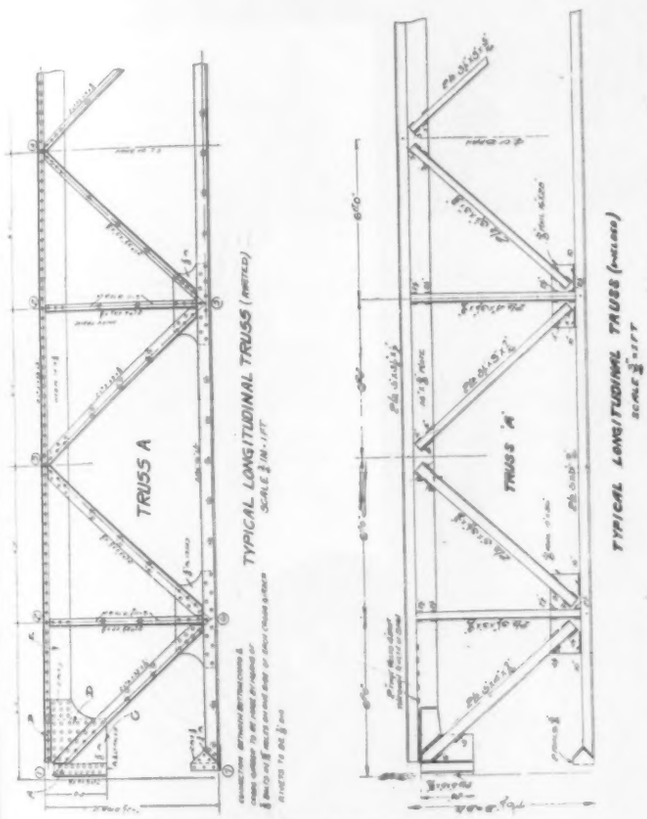


Fig. 24—Welded and Riveted Truss

There are 16 shop rivets in bearing on one ⅝-in. plate, which gives an allowable load of $16 \times 13{,}130 = 210{,}000$ lb. The safe load for shear which can be carried by the two angles is $18 \times 1 \times 10{,}000 = 180{,}000$ lb. The shearing of the angles rules in this case and we must have a weld which will carry at least 180,000 lbs. from gusset plate C to angles A. We will, however, design from the load supported by the rivets.

The net area of each angle on a horizontal plane $= 5.75 - 2 (1 \times ½) = 4.75$ sq. in. We can use either 2 — 5 x 5 in. x 9/16 in. angles or 2 — 5 in. x 5 in. x ½ in. angles with areas of 5.31 sq. in. or 4.75 sq. in. respectively.

Assuming that we use the former size of angle, then, we can use a 9/16-in. triangular bead, which is good for 4770 lbs. per linear inch. There would be required, then $\frac{210{,}000}{4770} = 44$ in. of weld. To be safe we will use 48 in. and weld along the edges shown at (b) in the side view, Sketch I, which gives us the required length of weld.

It can be easily seen that were the angles welded only along the edge (b) a bending moment would be introduced into the weld in addition to the shear which it is designed to carry. The joint would be unsafe. We must, therefore, make a weld also as shown at (a) Sketch I. At this point it must be brought out that we have no data on the strength of the type just mentioned. We are relying on it in this case simply to prevent a bending moment in the weld at (b).

Let us consider for a moment the connection of the angles A to the abutment or other support along the plane (cde) Sketch I. The load is 210,000 and we will use a 9/16-in. bead. There is required 44 in. and we will use 48 in. The angle 24 in. long is then sufficient and we will put a 9/16-in. bead along each angle at (dc).

It should be noted that the weld at (a) should not project beyond the plane (cd).

If now we should desire to use two angles 5 in. x 5 in. x ½ in. instead of those shown in Sketch I, the length must necessarily be more than 24 in., since a ½-in. bead is only good for 3195 lb. per inch of length. This would make a more unsightly connection, as shown in Sketch II. The length is $\frac{210{,}000}{3195} = 66$ in. and we should use about 70 in. This would mean about 35 in. along (dc) on each angle. (See Sketch 11).

Assuming that the weld as shown at (a) Sketch II is equivalent to two ¼-in. triangular beads with a safe load per linear inch of 1593 lb., then the length of 24 in. is sufficient in conjunction with the weld at (b). The preference, however, would be for the setup as shown in Sketch I.

Now let us consider the real limiting strength of the riveted angles. We have found that the maximum load which the riveted angles A will stand safely is 180,000 lb. and that the net cross sections is 18 in. long. In designing the welded joint the first question that arises is with regard to the required length of 9/16 in. or ½ in. angles. Using the former, the length of angles is $\frac{18}{1⅛} = 18 \times 8/9 = 16$ in. The length of the ½-in. angles must necessarily be the same as the riveted angles minus the eight rivet holes. This length is 18 inches.

The number of inches of weld required for this joint, using the 9/16-in. angles is $\frac{180{,}000}{4770} = 38$ in.

We will use 40 in. and put 16 in. on each angle. Weld also as shown at (a) Sketch I to take care of the extra 8 in. of weld which cannot be obtained otherwise unless the angles are cut 20 in. long instead of 16.

Using the ½-in. angles, the number of inches of weld required $\frac{180{,}000}{3195} = 57$ in. We would use about 60 in., which would require angles about 30 in. long.

Connection of ½-in. Plates D to Gusset Plate C

There are two plates D ½ in. thick which are connected to the ⅝-in. gusset plate C by 15 shop rivets in bearing on the ⅝-in. plate. The load to be carried is then $13{,}130 \times 15 = 196{,}950$ lb. We can use a ½-in. triangular bead which has a safe load of 3195 lb. per linear inch. The total number of inches of weld required $= 196{,}950$ divided by $3195 = 61.6$ in. We will use 64 in. and put 32 in. along each plate.

Upon closer inspection we find that probably 15 rivets are unnecessary for making this connection. Undoubtedly 9 rivets are sufficient and the other six are used only for adornment. This situation is brought out by reason of the fact that 9 rivets carry the whole stress from web plate E to plates D. This second consideration gives us $\frac{9 \times 13{,}130}{3195} = \frac{118{,}170}{3195} = 37$ in. We will use 40 in. and put 20 in. on each plate, as shown by (f) and (g) of Sketch III. We are rather uncertain as to the strength of a bead in the position of (f) and need test data on this point.

Connection of Top Chord Angles B to Gusset C

For the top member we have two angles 5 in. x 3½ in. x ½ in. There are 5 shop rivets connecting the top chord angles B to the gusset plate C. These rivets have an allowable carry-

(*Continued on page* 28)

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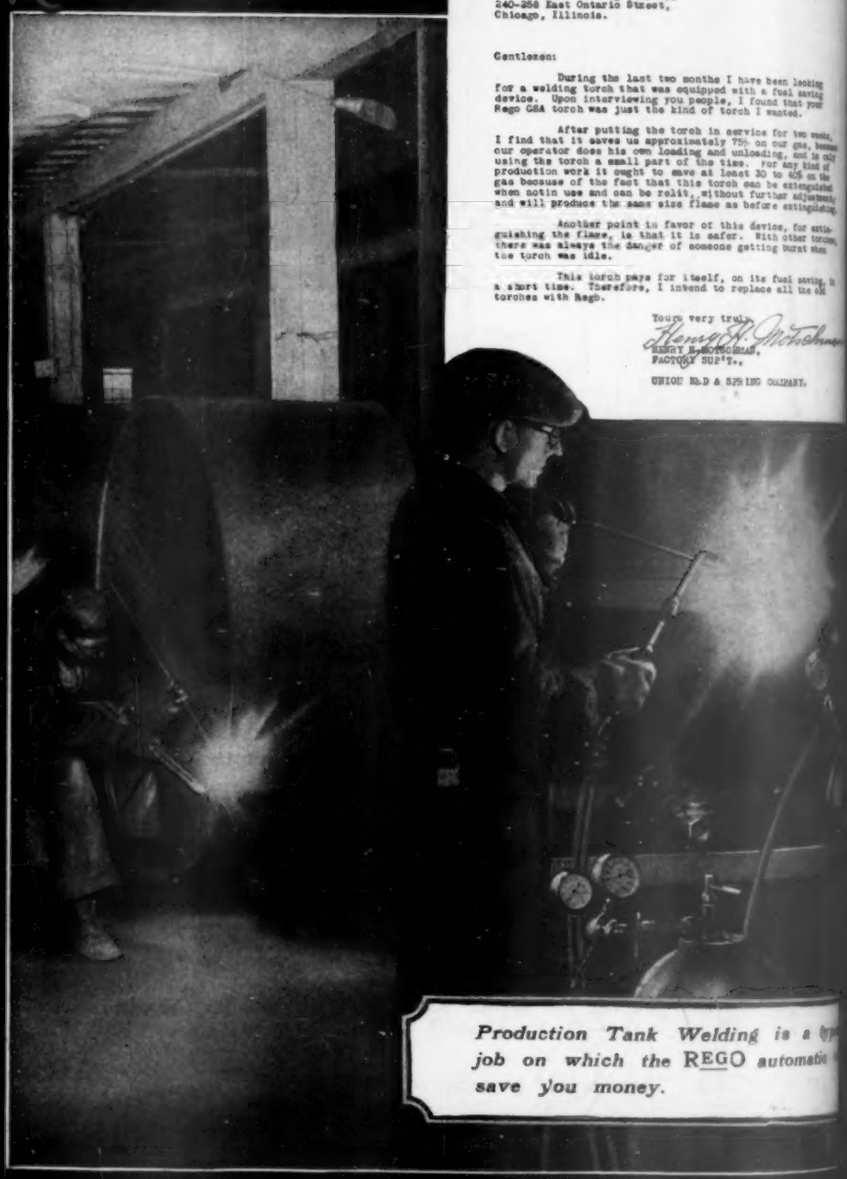

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FABRICATING LARGE STRUCTURES
Welded Truss
Part III

(*Continued from page 25*)

ing capacity of .5 × 13,130 = 65,650 lb. If we use a ½-in. bead we will require $\frac{65,650}{3195}$ = 20.5 in. of weld. We will use 24 in. In order to secure the proper amount of weld we will put 10 in. along one edge of each angle shown at (h) Sketch III and then put a weld of 10 in. on the top between the angles as shown at (k) Sketch III. The details of this last are shown at (e) Sketch III. We have no test data on the strength of a weld of this nature, but we assume that 10 in. of this type of weld will at least be equivalent to 4 in. of straight triangular bead.

Connection of Top Chord Web E to Plate D

There are 9 shop rivets connecting two ½-in. plates to one ⅝-in. plate. The limiting feature in this case is bearing on the ⅝-in. plate. The allowable load is then 9 × 13,130 = 118,170 lb. Using ½-in. bead there would be required approximately $\frac{118,170}{3195}$ = 37.1 in. of weld. We will use 40 in. and put 20 in. on each plate, as shown at (n) Sketch III.

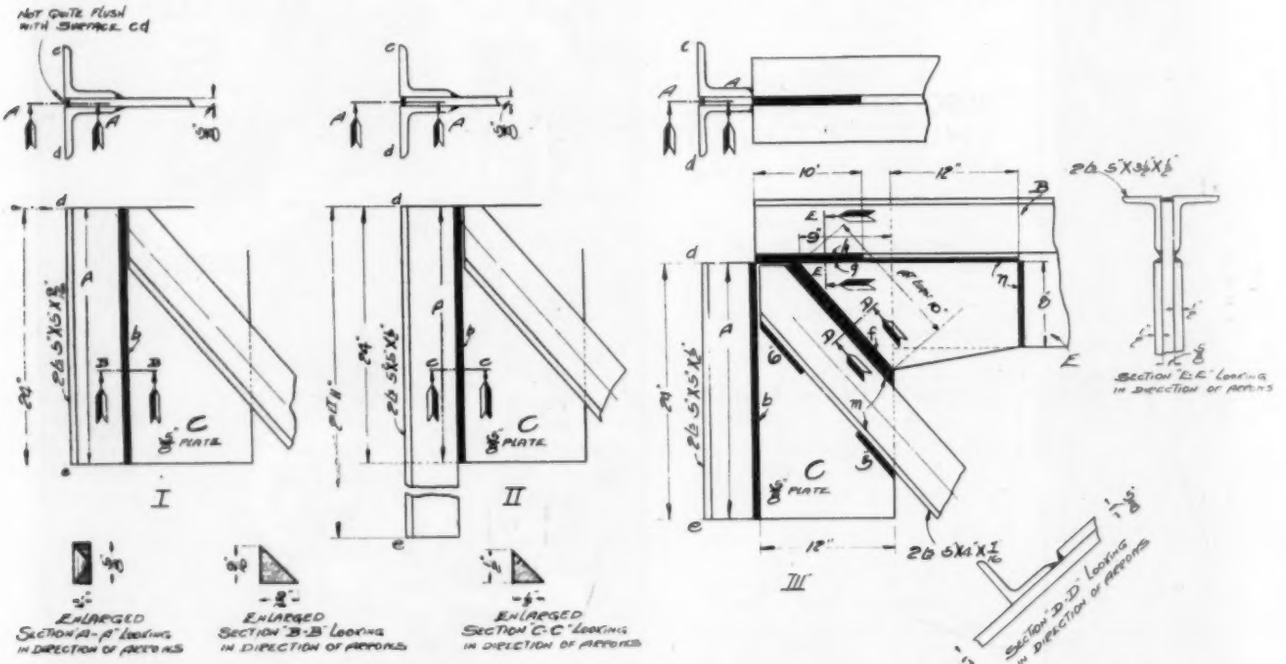
Member 1—6

This member consists of two angles 6 in. x 3½ in. x ⅞ in. having a net area of 3.533 sq. in. each. The allowable tension is then 7.066 × 16,000 = 113,000 lb. For welding we can use two angles 5 in. x 4 in. x ⅞ in., and we will therefore use a ⅞-in. bead. The number of inches of weld required = $\frac{113,000}{2781}$ = 40.7. We will use 44 in. and put 11 in. on each side of each angle, as shown at (m) Sketch III.

It should be noted that on all tension members we can save weight by reducing the size of the member, since originally is was designed on a net section. On the other hand, compression members cannot be reduced, since they were originally designed on the gross section of the angles using the column formula $(12,000 - 70\frac{l}{r})$ gross area, where l = length of member and r = least radius of gyration of the cross section of the member.

In the original design the tension members were designed with a net area of cross section greater than the amount necessary to carry the allowable load. In redesigning for welding from the riveted design the net area of the welded member is necessarily somewhat greater than that of the riveted member, so that the resulting design has a cross section and weight too great for the most economical design. This situation is inevitable when designing from a riveted design without knowing the actual stresses which will be imposed.

In the case of compression members the excess of strength over that required is considerably greater than in the case of the tension members. For instance, consider compression member 2—6, for which three rivets are used at each end to make the connections. The load which these three rivets can carry is 39,390 lb. Undoubtedly three rivets are more than enough to carry the load, but two rivets are not enough, as is shown by the following: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C
⅜" PLATE
I
II
III
ENLARGED SECTION A-B LOOKING IN DIRECTION OF ARROWS
ENLARGED SECTION B-B LOOKING IN DIRECTION OF ARROWS
ENLARGED SECTION C-C LOOKING IN DIRECTION OF ARROWS
SECTION E-E LOOKING IN DIRECTION OF ARROWS
SECTION D-D LOOKING IN DIRECTION OF ARROWS

Fig. 25—Details of Welded Truss Shown in Fig. 24

Consider the column formula $(12,000 - 70\frac{l}{r}) \times$ area of member. The load allowable on this member by this formula is $(12,000 - 70\frac{8 \times 12}{1.1}) 4.6 = 27,140$ lbs.

This shows that by designing the welded joint directly from the number of rivets we are making the joint stronger than necessary. In this instance we have recommended using 20 strength of the member in compression.

The above discussion brings out the point previously stated that the design of a truss from a riveted design is not as economical as the design of the same truss direct from the loading values. The discussion also illustrates the freedom which is allowed the designer of a welded structure because of the great elasticity of the welding process. It is possible to put just enough welding on and not necessary to put

more than enough to secure the proper strength.

The same general scheme holds true for the remainder of the truss and a general outline of the design of the various joints follows:

Joint No. 2
Member 2-6

Structural Forms, 2Ls 3½ in. by 3 in. by ⅜ in.
Allowable load = 3 rivets in bearing ⅝-in. plate = 3 × 13,130 = 39,390 lb.
Use ⅜-in. bead for the weld.

$$\text{Total inches of weld required} = \frac{39{,}390}{2394} = 16.5$$

Use 20 in.
On each angle put 5 in. of weld on each side.
Do the same at Joint No. 6 for this member.

Joint No. 3
Member 3-6

Structural Forms, 2Ls 5 in. by 3½ in. by ⅜ in.
Allowable load = 6 rivets in bearing on ⅝-in. plate.
= 6 × 13,130.
= 78,780 lb.
Use ⅜-in. bead for the weld.

$$\text{Total inches of weld required} = \frac{78{,}780}{2394} = 33 \text{ in.}$$

Use 36 in.
On each angle put 9 in. of weld on each side.
Do the same at Joint No. 6 for this member.

Joint No. 3
Member 3-5

Structural Forms 2Ls 5 in. by 3 in. by ⅜ in.
Net area = 2 (2.86 — 1.0 × ⅜) = 2 (2.86 — 0.375)
= 2 (2.485) = 4.97 sq. in.
Allowable load = 5.0 × 16,000 = 80,000 lb.
For welding use 2Ls 3½ in. by 3 in. by ⅞ in.
Net area = 2.65 sq. in.
Use ⅞-in. bead for the weld.

$$\text{Total inches of weld required} = \frac{80{,}000}{2781} = 29.0 \text{ in.}$$

Use 32 in.
On each side 3½ in. by 3 in. by ⅞ in. L, put 8 in. of weld on each side.
Do the same at Joint No. 5 for this member.

Member 2-5

Structural Forms, 2Ls 4 in. by 3½ in. by ⅜ in.
Allowable load = 3 rivets in bearng on ⅝-in. plate = 3 × 13,130 = 39,390 lb.
Use ⅜-in. bead for the weld.

$$\text{Total inches of weld required} = \frac{39{,}390}{2394} = 16.5$$

Use 20 in.
On each angle put 5 in. of weld on each side.
Do the same at Joint No. 5 for this member.

Joint No. 4
Member 4-5

Structural Forms, 2Ls 3½ in. by 3 in. by ⅝ in., wt. 7.9 lb.
Allowable load = 4 rivets in bearing on ⅝-in. plate = 4 × 13,130 = 52,520 lb.
Use ⅜-in. bead for the weld.

$$\text{Total inches of weld required} = \frac{52{,}520}{2394} = 22.$$

Use 24 in.
On each put 6 in. of weld on each side.
Do the same at Joint No. 5 for this member.
Remainder of Truss is the duplicate of this half shown.

Bottom Chord

Structural Forms, 2Ls 6 in. by 6 in. by ½ in., wt. 19.6 lb.
Net area = 2 (5.75 — 1.0 × ½) = 2 (5.75 — 0.500)
= 2 (5.25) = 10.50 sq. in.
Use 2 Ls 5 in. by 5 in. by ⅞ in.

Joint No. 7
Connecting Angles to ¾-in. Plate

Structural Forms, 3 shop rivets in double shear = 3 × 14,430 = 43,290 lb.
Use ⅞-in. bead.

$$\text{Total inches of weld required} = \frac{43{,}290}{4770} = 9.1 \text{ inch.}$$

Put 6 in. on each angle cutting L at 45 deg.

Connecting ⅜-in Plate to ¾-in. Plate

Structural Forms, 3 field rivets in double shear = 3 × 12,030 = 36,090 lb.
Use ⅜-in. bead.

$$\text{Inches of weld required} = \frac{36{,}090}{2394} = 15.1$$

Use 16 in.
Put 8 in. on each plate.

Joint No. 6
Gusset Plate

Structural Forms, one ⅝-in. plate, 11 shop rivets.
Allowable load, bearing on ⅝-in. plate, 11 × 13,130 = 144,430 lb.
Use ⅞-in. bead for the weld.

$$\text{Total inches of weld required} = \frac{144{,}430}{4770} = 30.4 \text{ in.}$$

Use 40 in.
Put 20 in. on each angle.

Joint No. 5
Gusset Plate

Structural Forms, 11 shop rivets at 13,130.
Use 20 in. on each angle, as for Joint No. 6.

At this point it should be stated that as the art of welding becomes more and more an important factor in the structural field, standardized designs will be evolved which will render the design of welded structure more simple. In the present instance some of the joints used might be considered crude and might be improved upon, but it should be borne in mind that we have no practical data on this phase of the subject.

The writer desires to acknowledge the great assistance rendered by Prof. Frank P. McKibben of Union College, who assisted materially in the preparation of this design, both with regard to methods of designing the welds and many helpful criticisms on the subject matter.

(Concluded in the April issue)

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The Welding Engineer

Founded by L. B. Mackenzie, 1916

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A Hard One to Beat

THE wrong attitude towards training welding operators and helping them to learn more about their work is present among the smaller users of the process. This is a very bad condition for without intelligent welders the process will not be able to expand as rapidly as it should. Just recently the matter of subscribing to this publication came up with such a manufacturer, after the merits of the plan were submitted he merely answered, "Well, if we did get your paper, the welders would read it and get dissatisfied with their work. They would learn how to do other kinds of welding. They might go around to the meetings of the different societies. If a man is any good he will learn a lot from your paper and from the meetings. The first thing we know he wants more money, he knows more about welding than we do, and pretty soon we lose him. He has found a job as welding supervisor or foreman. If the man isn't any good, he won't get anything out of the paper and so it is a loss either way. It costs a lot of money to hire new help and we're satisfied to get along as we are now. We find that 'Hunkies' do the job all right and they're cheap anyway." No amount of effort was able to convince this man that it is up to him to help the man who wants to get ahead and learn more about his work. This case may seem extreme, but it is not, it is more nearly the rule than the exception among the small users of the welding process. They are the very ones who need information the most. Their welding methods are generally very far behind the times. It is the duty of the advocates of welding to see that this condition is changed and that the employer and manufacturer is educated as well as the welder.

The Human Element

WELDING advancement is directly dependent upon the human element which enters into each and every weld. The welder must be made to realize this. The greatest drawback to the entire industry is the welder who doesn't understand the fundamental principles of welding. With him it is a question of guesswork and luck. If the weld holds, he thanks his stars, if it doesn't, then the welding process is to blame, it isn't applicable to the job or else something else is the matter. This is simply due to ignorance. Still the fact remains that the limitations placed upon welding by the regulatory bodies everywhere have been loaded on to take care of just this very thing. The human element in welding is present in every weld. It is a thing which must be beaten. The only way to beat it and keep it beaten is to instruct the welders and see that no welder is allowed to make a weld until he knows all there is to be known about the particular job he is doing.

Bale Wire Is Good Enough

"NO you can't get our welder to use any of those new fangled, fancy colored wires. He is a foreigner and won't even listen to the different salesmen when they come around. One fellow left some samples a long time ago and they are still here. Our welder gets fine results with bale wire and as long as he's satisfied, we are." Wrong attitude again, and one which shows complete ignorance of the progress being made in welding. Anyone knows that in some bale wire or some fence wire the properties for welding are present. They are there because of the materials which went into their manufacture. However, these properties are not always present. Bale wire does not run true to specifications, particularly welding specifications. Some of it flows rapidly and makes a fair weld, while the next batch may not flow well and may make poor welds. When such welds fail, welding receives a black eye. According to a welding wire manufacturer it is hard enough to keep the wire uniform so that the results will be uniform, even when the wire is made to certain strict specifications. This one argument ought to be enough to warn the welder against the use of haphazard material and filler rods.

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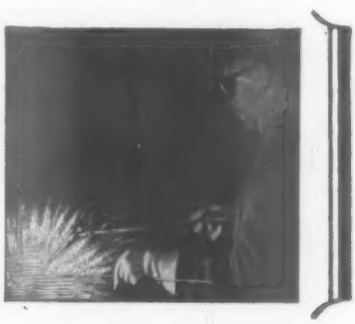

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"Torch Operator" or "Welder"

Specialized Training Does Not Make Men Capable of Doing Diversified Jobs—Working Knowledge of Entire Art and More Instruction Needed

By R. K. Randall*

PICK up a newspaper in most any city of size in the country today and you will see very few days, advertisements like this: "Wanted—Welder, experienced on such and such a kind of work." What thoughts enter your mind when you read it? I am frank to say that I always smile. I recently saw two such advertisements in a city newspaper. One referred to a man with "steel barrel" experience and the other with "experience on light metal furniture." Can you imagine it, how many "welders" in the country can honestly say they have ever welded a steel barrell or welded on metal chairs or desk; yet how many real welders would be afraid to hire out on either job and worry for fear they would not make good? None.

I am going to cite an actual incident that happened a while back in our school here. A young man came in to see us and wanted some information as to the cost, etc., of our acteylene welding course. We went thru the usual form of questioning him and finally came to the question of "what kind of work do you do at present," imagine our surprise when he said that he had just quit his job a week ago but that he had been working "two years as a welder." Upon further questioning we found that his case was as follows: Two years ago he had been working in a shop where light sheet metal work was welded. He was a likeable chap and finally had prevailed upon the foreman to give him a chance to "break" into the welding department, with a little assistance from one of the other men he had mastered the "neutral flame" and managed to weld the article he was supposel to, rapidly and well. He worked on piece work and actually made on the average of $1.00 an hour. However, one day he and his foreman had a disagreement and he "quit," feeling secure in the thought that he was a welder. He went out and hired out as a welder where various kinds of work were done and was "fired" before the morning was over. He got another job in a foundry and had the same success, "couldn't do the work" was their excuse to him. This young man however, had some stuff in him and sat down and took stock of himself. He came to the conclusion that in spite of the fact that he had been handling a welding torch for two years that he was not a "welder" but a "torch operator" highly skilled in a particular line of work. This man liked welding and wanted to continue in it so he sought education in his work in the only place he knew of and that was a trade school.

Let us pause and look for a moment at the industries which today have a tendency to train "torch operators" rather than welders; pipe welding is one of these fields. In a recent article on "pipe welding" I found this statement, "and others were trained for the work as occasion demanded." The trouble is, they are trained as torch operators or specialists and not welders. After they learn their job, for one reason or another, they drift here and there and then we find them in shops where other work besides pipe welding is done and they are attempting work with which they are not familiar, spoiling more or less work and doing some that, while passable, is not up to the standard it should be. How many pipe welders would know where to use Manganese Bronze instead or Tobin, or know just why a certain cast iron weld was hard instead of machinable? On the other hand, the cast iron foundries train a welder to execute cast iron work of high quality, but should occasion arise for the execution of a difficult steel weld, where would he be?

These comparisons could be carried on indefinitely. It seems to me that the welding world is confronted with the question as to whether or not this is a desirable condition. As I see it, it is a condition that is not going to help our industry. While I do not deny that a certain number or torch operators are necessary, as a matter of fact desirable, I do think the idea is generally to be discouraged. My reasons for this conclusion are these; first the torch operator is not apt to realize his limitations and spoil work, or in his attempt to do a class of work that he is not familiar with may prejudice someone else against the process, the assumption being that the average foreman relies wholly on the welder's word and skill, the foreman generally not being familiar with welding. Second, the torch operator himself may be discouraged with his failures and decide that he is not adapted for this work rather than realize that what he lacks is further knowledge of the process. In this way many desirable recruits are lost to our trade. What then is the solution?

One fact that I should like to mention here is the fact that every welder should feel that he himself can be a teacher in the broadest sense of the word by passing information he may have along to his fellow workers. Too many times the average welder will watch some man struggle thru a welding job in a difficult and perhaps wrong way when a kindly word of advice would help the other fellow so much. This advice can be given in such a way that the other fellow will not feel belittled, but rather be made to feel grateful. Too many welders I am afraid, take the attitude of "let him learn the way I did." Most men in the welding industry have gained their knowledge thru reading and being associated with men who took interest enough in them to school them in the various ways to handle their welding work and they in turn should be as ready to pass on their knowledge to the other fellow. The good that would result if every welder would try to help and teach the other fellow in their daily contact with them is immeasurable.

There has been gathered together by the Educational Committees of the A. W. S. and the Gas Products Association, material and data enough for a comprehensive, intelligent and practical welding course. The next step is to get this training and information to the welder. How it is to be done is more or less of a local problem but a few suggestions are offered here.

First, by the individual plant survey in industries employing a number of welders. From what I have seen and heard in various plants, I feel the suggestion of the forming of a class to further the education of their men would be welcomed. These classes could take one hour out of every three or four working days and meet, say from 4 to 5 p. m. and have the theory of different welding problems laid before them, the theory to be followed up with practical demonstrations by the instructor.

The second suggestion would be to get the smaller manufacturers, where only a few welders or perhaps only one welder worked, to pool their interests and meet in first one plant and then in another and collectively get their instructions. This same general scheme could be worked out for a foreman's class. It would give the foreman a chance not only to receive the proper welding theory but in the discussions that followed a wider range of welding vision would result.

The third suggestion would be the utilizing of some school already existing, or in the establishing of training centers, these

*Welding Instructor, Cleveland School of Technology.

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centers to be located so that they would be convenient to a large number of men from a certain area.

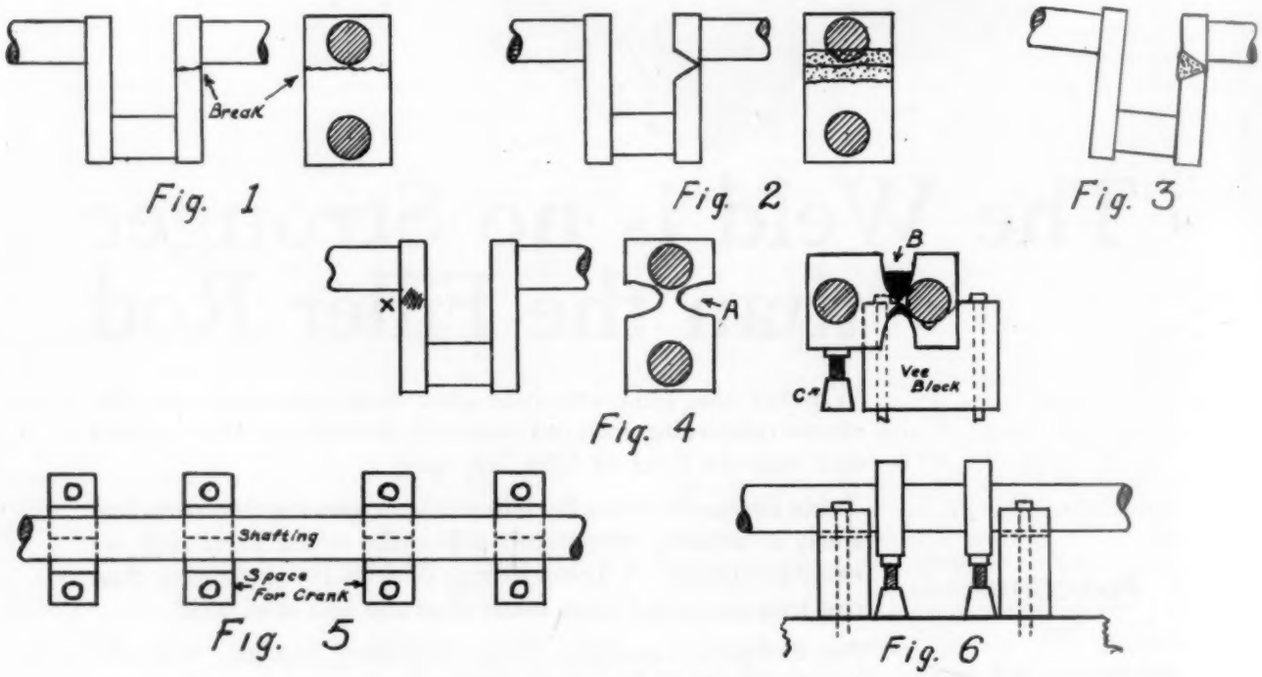
I firmly believe that the manufacture of welding equipment both gas and electric, the manufacture of gases and even firms manufacturing welding wire would be repaid by the formation and financing of such educational work as I have suggested; both by increased application of the process and greater demand for their apparatus and welding wires due to increased efficiency.

Training of this sort would eliminate the man experienced on "steel barrells" and "light furniture" and produce some welders with knowledge and skill enough to know that welding is welding whether on a barrell or a locomotive.

CRANKSHAFT WELDING

By W. J. Field, New Westminster, Canada

In crankshaft welding the realization of a good weld, while very important does not guarantee a satisfactory job. For this reason those who have not had any experience in this work may profit by studying the accompanying rough sketches and reading the remarks in connection with same.



How to Weld Crankshafts

Fig. 1 shows a crankshaft broken through the web close to shaft, so close, in fact, that there is no possibility of preparing a double "V" across the face of web so we will prepare it by cutting a single "V" across the face of the web as shown in fig. 2. The difficulties to overcome are numerous.

1st. If we place the shaft in a horizontal position, we have to weld vertically.

2nd. If we place the shaft vertically, we have difficulty in supporting it and maintaining alignment.

3rd. A single "V" entails a considerable amount of welding.

4th. The contraction of the welded area would produce results similar to that illustrated in fig. 3.

Let us now consider fig. 4. It will be seen that as the face of the web is wide, to cut a 90° "V" reaching to the center would represent a considerable amount of welding. We will reduce the amount of welding by cutting out two "V's" as shown at A fig. 4. The next matter to consider is how shall we line up our shaft. First we need a good level surface, some "V" blocks, and a length of straight shafting, and bolts, nuts, and plates to secure the "V" blocks and shafting. We will now space our "V" blocks so that when we remove the shaft after fastening the blocks, the crankshaft will take its place. Fig. 5 shows "V" blocks spaced in line and fastened down. After placing crankshaft in its cradle of "V" blocks and making sure that the broken web is in a horizontal position, we will fasten the crankshaft down and place a small jack C under web at crankpin as a support, in fact another jack under the other web fig. 6 would do no harm. Now we will take another look at fig. 4 and must take into consideration that if we start welding the fracture, we will certainly produce expansion, so in order to avoid distortion, we will heat up the other web at point marked X. After heating, we will proceed to weld and will discontinue welding when we have completed half the first "U" as shown in fig. 4 at B. Now slacken off the plates holding down the crankshaft and give shaft ½ turn, again fasten down shaft and completely fill up 2nd "U." Now turn to original position and complete welding on 1st "U." Both the heated and welded sections should now be covered up, preferably with a sufficient body of sawdust to exclude the atmosphere and allowed to cool slowly.

WROUGHT IRON PIPE BENDS

Rohrbogenwerk, G. M. B. H., Hamburg 23, has recently put out a catalog of "Wrought Iron Pipe-Bends" for weld and flange connection. In this catalog it is pointed out that the bends have a uniform thickness of wall, a smooth surface, minimum weight, circular cross-section, small bending radius, and that they are simple to erect. This booklet consists of sixteen pages and a cover and may be had in either German or English. It is attractively illustrated with photographs and diagrams of this process and also goes into the history of pipe bends. This booklet should be of interest to refrigerating engineers and to all those interested in welding pipe coils and pipe bends. The illustrations are very interesting as they show so many actual installations of this sort of bended pipe in the refrigerating, chemical, heating, machinery, hydraulic, hygienic and shipbuilding industries.

CORRECTION

In the January 1925 issue of *The Welding Engineer*, on page 37, the credit line was omitted from the article entitled, "Power Plant Cutting and Welding." This article was reprinted from Oxy-Acetylene Tips, August, 1924, by Courtesy of the Linde Air Products Co.

A Letter from Australia

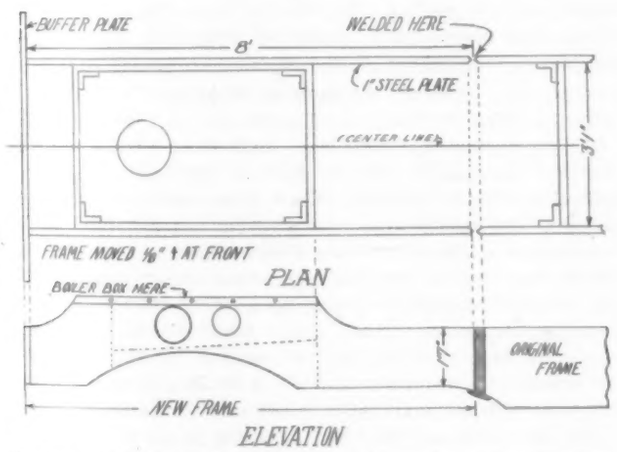
One of Our Friends in Western Australia Writes of the Growth of Electric Arc Welding—Gives Details of Locomotive Frame Welding

Dear Editor:

For some time I have been an interested reader of the various articles contributed to *The Welding Engineer* by those associated with the welding trade. I am an arc welder and am writing because I might be able to give you and your readers an idea of the progress being made by arc welding in Western Australia.

Photograph A—Locomotive Frame Welded and Reinforced by Stiffening Plate

In photograph A is shown a locomotive frame welded at a fracture and reinforced by a stiffening piece welded on top. I completed this weld about 18 months ago, and it is still in service. It was fabricated with a D.C. welder using $\frac{5}{32}$" mild steel electrodes. Photograph B shows the bottom part of a firebox wrapper plate welded on both sides. The welding on this job was done by a boiler shop welder and another make of D.C. machine using a $\frac{5}{32}$" and a $\frac{1}{8}$" electrode as the occasion demanded. When subjected to a severe test this job showed no leaks and it has since held up satisfactorily under eighteen months' actual service.



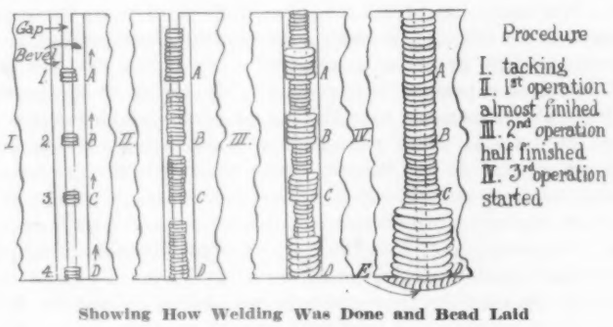
Plan and Elevation Showing Details of Locomotive Frame Welding Job

I have just completed an interesting job which I guess I will tell you about. Here are some rough sketches which will serve to illustrate the job better than words. The front portion of the frame of one of our locomotives was found to be corroded so badly around where the cylinders bolt on that it was decided to weld two new pieces to the original frame. The sides of the frame are of one inch steel plate. After the parts to be scrapped were cut off with the torch, the edges of the original frame were Veed out by the torch and then chipped up with a cold chisel. The two new side plates were then prepared with all the holes drilled, fitted and bolted together onto the plate and angle iron box. This box fits between the frame where the smoke box sits.

As the new cylinders were fitted to the engine, the holes for these were left until after the welding was done. The new plates were then set up as one piece on solid packing. They were held in line at the weld by one inch plates and heavy clamps. The preparation of the job from a welder's point of view was execellent, the gap being $\frac{1}{8}$" and the bevel 90 degrees.

Photograph B—Arrow Points to Bottom of Fire Box Wrapper Plate Welded on Both Sides

First I tacked each side at A, B, C, D inside and outside, this is shown in the drawing. At each tack I put in about one inch of welding and just a little more than the amount necessary to fill the gap. Next I welded from A to A′, B to B′, C to C′ and D to D′ inside and outside the frame in the order named. Then I almost filled the Vee welding from A to A′ and so on as described before. The next operation was to put on a half inch reinforcement at E on the bottom of the weld, starting at D and working up. This was the first time that I have ever tried working to a set order and I found that the results were excellent and much better than working on the "hit or miss" plan. The plates were not buckled or overheated at any time. The only work that had to be done after the welding was completed was to peen the frame back about $\frac{1}{8}$" as shown in the center line in the plan. Only $\frac{1}{16}$" contraction took place and as this was allowed for in the set up everything came out all right. This job



Showing How Welding Was Done and Bead Laid

was electrically welded and 3/32" electrodes were used. The actual welding time was 10 hours, without helper and 161 electrodes were used. Trusting that my tale will be of help to some one else in the industry, I remain,

Yours with the Arc,

H. H. Marsh.

RAIL JOINT TESTS REPORTED TO COMMITTEE*

Stresses on Joints in Service; Tests of Strength and Resistance to Impact, Reported at Bureau of Standards Meeting

PEBBLES placed on a street car rail more than doubled the stresses set up in the rail when cars ran over it during tests made by the Bureau of Standards. These tests were made for the purpose of determining the stresses to which rail joints are subjected in actual service, and were among the tests on which progress reports were made to the Committee on Welded Rail Joints at a meeting held at the Bureau of Standards on February 16, 1925.

The tests on joints in service were made by clamping onto the joint an electric telemeter, or strain gage, of a type invented by the Bureau of Standards, and with it recording automatically the changes in stress when a car went over the joint. In one case the gage showed a tensile stress of 2,000 pounds per square inch when the rail was clear, and 5,000 pounds per square inch when pebbles were put on the track.

Other tests reported to the committee were planned to measure the strength of joints in various ways. All types of welded joints are being thus tested, and it is the purpose of the committee to improve each of these types rather than to prove that any one type of joint is the best.

Tests now in progress include measurements of the bending strength under steady load, being made at Purdue University; measurements of the blow required to break the joint, being made at the University of Illinois; and tensile tests and repeated impact tests being made at the Bureau of Standards. Metallurgical examinations of the joints are also being made at the Bureau of Standards, and measurements of electrical resistance are being made at the Bureau of Standards and at Purdue. One of the objects of welding the joints is to provide a continuous return path for the electric current and lessen the damage done by electrolysis of nearby pipes and other buried metal objects by currents straying from the line.

Otheograph Can't Stand Racket

The proposal to use the otheograph developed by the General Electric Company in connection with the tests was brought up. This instrument has been used successfully on a track the company uses for testing new electric locomotives, the speeds attained running as high as 106 miles per hour.

Doubt was expressed, however, as to the ability of the device to stand the tremendous pounding caused by flat wheeled cars and corrugated tracks which represent the worst extreme of electric railway service. It was reported that a blow with an eight pound sledge made a reading on the otheograph as high as did the heaviest locomotive with which it had been used. A four hundred pound hammer is used with the repeated impact machine in which the welded joints are being tested.

Questions regarding the methods of making joints for test were taken up, and it was judged best to have each type of joint made by a welder experienced in that particular type. Evidence was presented to show that any welder was likely to make the best joints of the type to which he was most accustomed without regard to the merits of the joints.

In the afternoon the committee went out to see the machine being used by the Bureau of Standards for the repeated impact tests. This machine has a 400 pound hammer which is raised about six inches off the joint and allowed to drop. The racket is tremendous. The machine has been housed in a shack in the woods, and it has proved difficult to keep a man on the job for any length of time, five having been employed since the test was started.

This committee is sponsored by the American Bureau of Welding, in cooperation with the American Electric Railway Association, and is composed of representatives of electric railways, manufacturers of welding equipment, and others interested in the subject. Dr. George K. Burgess, director of the Bureau of Standards, is chairman of the committee, Mr. E. M. T. Ryder of the Third Avenue Railway System, New York City, is vice-chairman, and Mr. W. Spraragen of the American Bureau of Welding is executive secretary. The program of tests has for its object the finding of ways to make the best possible joints of all types. It is being supported largely by voluntary contributions from those concerned with the making and using of such joints.

Department of Commerce, Washington.

A CASE FOR WELDING

By Frank C. Hudson

The tire problem is one of the worst that confronts the average railroad motive-power department—especially on a road with many curves. Tires themselves have changed very little in ten, or even twenty years. The steel is not materially different, according to Lawford H. Fry, and every shopman knows it is about the hardest stuff that comes into the shop to machine. Twelve feet a minute is probably the average cutting speed, with the best tools money can buy.

Then there is the waste of tire material by turning down tires because the flange has worn thin. I saw, only the other day, a pair of 66-in. tires being turned in a new wheel lathe that was ripping the metal off at a good rate. The cut was about a half-inch deep and the feed perhaps a quarter inch. Not a flat spot on the tire. All that metal, which meant miles and miles of wear, was being sacrificed because the flanges were worn thin. And because they were thin, a half-inch of tread had to be sacrificed in order to leave material enough for a flange of the required thickness.

Some shops I've seen are building up the worn treads by either the arc or acetylene process. The steel wizard tells us it is criminal and that all sorts of dire disaster is liable to happen. But many of these doctored tires are in use and giving good mileage, saving the awful waste of good tread material as mentioned before.

There have been, of course, some failures from built-up tire flanges. I don't seem to remember any practice that is quite one hundred per cent perfect. But the fact that even a few of these built-up tires give a good account of themselves, ought to warrant careful investigation of the process.

What Happens in Welding

Here is one of the many cases where there is a crying need for a railroad testing-laboratory that shall serve all the railroads.

Let the steel sharks make all kinds of tests with all kinds of welding or filling in methods. There is no question as to the local heating to the fusing point set up severe internal stresses. But there may be a way of relieving these stresses by annealing, even without removing the tire from the wheel center. The fact that some flange-filled tires are giving good service without annealing, shows that the stresses are not always fatal. The main thing is to know what happens under this process and whether or not it is safe practice for the railroads. If it is, they should all use it when conditions warrant. If it is not safe, it should be taboo.

With flat spots on tire treads, turning is probably the only thing to do. But it certainly seems like a shameful waste of good material to turn off a good tread for a thin flange. Then too, there is the machine overhead of a costly wheel-lathe to be considered.

The cost of research work along this line can be paid for by the salvaging of a few hundred sets of tires. The cost of tires with only normal wear is considerable, because they can only be worn to about half the original thickness. And when we waste any of this good tire tread we are throwing money away.—*"Back-Shop Talks"—American Machinist, December,* 1924.

Aluminum Alloy Castings Reclaimed†

Soldering and Welding Used in Salvaging and Reclaiming— Economic Aspects of Castings Salvage— Salvage Specifications

By Robert J. Anderson* and M. Edward Boyd**

THE object of this paper is to discuss the economic and metallurgical aspects of the salvage of defective aluminum-alloy castings by the usual methods of soldering and welding. As is well known, in the production of aluminum-alloy sand castings, a variable percentage of the castings poured, say 15 per cent on the average, is spoiled because of the occurrence of certain typical defects, e. g., cracks, blows, draws, holes, *et al.* Certain of these wasters admit of salvage by effecting repairs at the defective places, and, in American foundry practice, welding and soldering are the two methods most extensively applied.

Since aluminum became an important engineering material for construction, much time has been spent in developing methods for making joints in the metal and its alloys, and at the present time the usual methods employed in practice are oxy-gas welding and soldering. Electric-resistance and electric-arc welding methods are in use, but these have not yet found general application. The literature on soldering and welding aluminum and its light alloys is quite extensive, but most of the published papers deal with the technique of making welds and soldered joints, and the metallurgical aspects of the subject have been considerably neglected. At the present time, welding is extensively used, in the aluminum industry, as a manufacturing process for the construction of large tanks, vats, and other vessels for use in the chemical industry; in the manufacture of aluminum cooking utensils, e. g., for attaching cast or stamped spouts to spun bodies; in the repair of broken automotive and machinery parts in aluminum alloys; and in the salvage and reclamation of castings in foundry practice. Soldering should really have very limited application in aluminum work, as will be shown later, but it is employed in the salvage of castings and also for making joints.

With simple castings, the loss due to wasters may be quite low, say 4-7 per cent, but in complicated castings, like crankcase upper halves for 8-cylinder motor cars, it may be as much as 20-25 per cent on the average. Of these losses, some 50 per cent is reclaimed by soldering and welding, and additional reclamation is made of porous and leaky castings by treatment with sodium silicate.

Economic Aspects of Castings Salvage

While there is a large field of application for welding in the production of aluminum and aluminum-alloy manufacturers and in the repair of parts failed in service, especially broken automobile castings, the employment of welding in the foundry as a means for salvaging defective castings is of great commercial importance. Soldering is, of course, of little importance in the production of manufactures, but it does have some legitimate application in castings salvage.

In the job-welding shop, the bulk of the aluminum-alloy work presented for repair consists of broken, or otherwise damaged, crankcases, gear boxes, housings, and other automotive castings. The problem of the job welder is the repair of such broken parts so that they may be put into service with the least possible delay and at substantial saving over the cost of a new part. Welded repairs are made upon any type of break that admits mechanically of repair by the process, and no restrictions are laid down as to what types of repairs may be effected. The welded joint of a fracture may be built up well so as to ensure ample strength, and large fractures, holes, and breaks may be repaired with no special regard for appearance. In the case of repair welds, the customer understands that he is getting a repair job, and he looks for service rather than appearance and technicalities. The application of repair welding to a broken housing is shown in the accompanying Figs. 1 and 2.

The problem of salvaging defective castings in the foundry is considerably different than that of repairing old broken parts. In foundry practice, salvage is effected for the purpose of making merchantable castings from parts that would otherwise be scrapped because of specific defects, and the economic importance of reclaiming castings containing remediable defects will be shown in later paragraphs of this section.

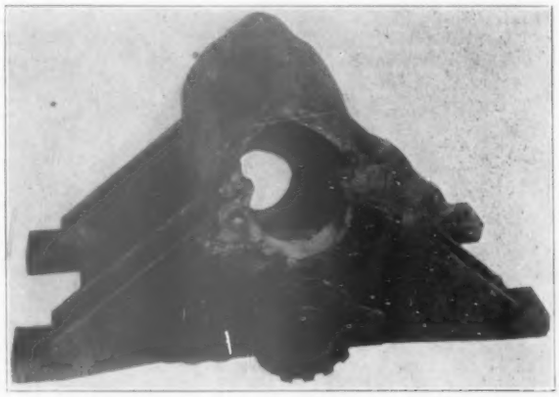


Fig. 1—Broken Housing

In the case of castings found to be defective on inspection in the foundry and of new castings returned from the machine shop, care must be taken in salvage repairs so that the part will not have the appearance of having been repaired, or at least a salvaged casting should not have the appearance of having been seriously defective prior to repair. Of course, it is understood that defective new castings should be reclaimed according to sensibly rigid salvage specifications for important parts, and they should never be repaired if there is the possibility that they will fail in service at the point of repair and through localized weakness because of the repair. Solder repairs should be made only rarely (cf. Metallurgical Aspects of the Salvage Problem, below), while weld repairs should not be made on stressed members or on parts whose failure in service might endanger life. A single failure traceable to a casting inadvisedly salvaged by welding or soldering would be many times more expensive, to a manufacturer of motor cars through damage to his reputation, than the cost of a new casting. However, even with strict limitations imposed on foundry salvage, there is considerable scope of application for weld repairs to defective new castings. It should, of course, be emphasized that such salvage should be carried out only under expert supervision and according to practical and sufficiently rigid specifications.

The importance of castings salvage in aluminum-alloy foundry practice may be properly appreciated only by a consideration of casting losses and the relation of possible salvage to the wasters

†*Extract from paper presented before American Foundrymen's Association.*

**Consulting Metallurgical Engineer, Boston, Mass.*

***Clinton, Mich.*

produced. Table 1 gives some data on casting losses and salvage by welding in the case of aluminum-alloy castings produced in an automotive foundry. Taking the case of the variety of automotive castings, out of 2,093 castings poured, about 51 per cent were found defective on first inspection, and of total defectives some 39 per cent contained defects which admitted of repair by welding. In the other two examples shown in the table, the importance of welding as a method of salvage may be noted. In discussing this matter with three representative founders, the following information was furnished: In a large automotive foundry, the average casting loss for a variety of automotive castings, but principally crankcases for an 8-cylinder motor car, is 20 per cent, i.e., 20 per cent of the castings poured are rejected on first inspection. Of this loss, some 90 per cent is salvaged by welding. In another automotive foundry, the average casting loss for 6-cylinder crankcases is 10 per cent, and half of this loss is saved by soldering small and localized defects. In still another plant—a large jobbing foundry—the average casting loss is 8 per cent, and some 60 per cent of the loss is reclaimed by soldering or welding, depending upon the type of defect.

Table 1

Casting losses and salvage of castings by welding,

Type of casting	Total number of castings poured	Number of castins accepted on rough inspection	Number of castings totally rejected on rough inspection	Number of castings amenable to salvage by welding
Variety of automotive castings,	2,093	1,018	267	808
Motor crankcase,	502	270	18	214
Differential housing,	438	242	100	96

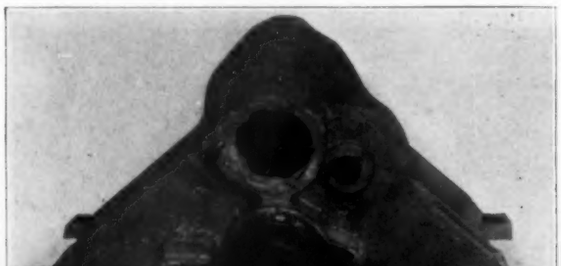


Fig. 2—Fracture Built Up by Welding

While precise data are not kept in the majority of foundries as to the savings made by salvage, it is obvious that the savings are very substantial. Estimation of the monetary value of the savings effected in the American industry has been made by the writers on the basis of average figures for casting losses, percentage of loss reclaimable, the cost of scrapping castings per pound, and the total production. The first three items are very variable in different plants, depending upon local conditions, but for purposes of calculation the following average figures may be taken; viz., average casting loss, 15 per cent; percentage of loss reclaimable, 50 per cent; and cost of scrapping castings per pound, $0.15. The total amount of aluminum-alloy castings may be taken as 100,000,000 pounds per annum. Then, the saving owing to reclamation is of the order of $1,125,000 per annum in the United States. For a plant with a production of 10,000,000 pounds per annum, the saving should be of the order of $100,000 at least. This is a very substantial item and indicates much better than a simple statement the necessity for first-class supervision in the salvage department.

Specifications for the Salvage of Aluminum-Alloy Castings

Generally speaking, the problem of salvaging defective castings in aluminum-alloy foundry practice is not handled in a systematic manner and under metallurgical supervision. Such salvage is usually left in the hands of an inspector, who, in the interest of production, turns all defective castings over to a welder who proceeds to plaster them with solder or else welds everything indiscriminately in the attempt to save all defectives. Although a considerable number of castings are reclaimed by this method of disposition, the general result is that castings which should be welded may be soldered or *vice versa*, and many castings may be ultimately scrapped because of poor repair technique,

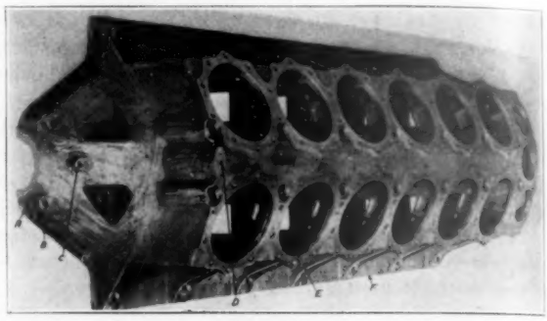


Figure 3

cracks on welding, or unsightly welds. Certain types of defects, depending upon their size and situation on the casting, admit of repair, while others are never reclaimable. Inspection of defective castings under competent metallurgical supervision is the only method by which it is possible to determine what defects may be safely and economically repaired.

While no general rules can be laid down to cover the reclamation of defective castings, since salvage depends upon the type of defect, the use to which the casting is to be put, and other important factors, it may be stated broadly that small cracks, surface blows, sand holes, cold shuts, draws, and breaks, are representative of the defects that are repairable by welding. It should be pointed out that in some plants all salvage is done by welding, while in others soldering only is used, while in still others soldering or welding is employed depending upon the nature of the defect. Both soldering and welding have distinct applications in castings repair, and either one should not be used to the exclusion of the other. However, a safe rule to follow is to exclude the use of soldering and to weld all repairable defects. Soldering is prohibited entirely upon rough castings in some shops, but is used on machined and semi-finished castings which cannot be welded because of warping that would ensue. Soldering may be permitted where the joint to be made is free from strains of any kind and where it is not to be exposed to moisture or other agents that would induce electrolytic corrosion between the solder and the casting. Actually, the use of soldering should be quite rigidly restricted, and its primarily useful purpose is to improve the appearance of a finished casting.

As indicated previously, machine-shop scrap is returned to the foundry for repair, and such scrap is the result of (1) machining errors, such as undercuts, oversize holes, imperfect threads, broken taps or drills left in the castings, and the like, or (2) foundry defects, such as may be uncovered on machining. Internal strains in castings are released on machining and, if of sufficient magnitude, may cause cracks.

In considering the types of defects which admit of repair, it is of rather more than passing interest to consider specifications governing salvage. So far as is known, definite salvage instructions are issued in but few plants. The instructions issued at the plant of a motor-car manufacturer and those governing the reclamation of castings for the Liberty 12-cylinder aviation engine may be cited as representative.

Salvage at an Automotive Foundry:—Taking up first the case of the salvage instructions in force at an automotive foundry, the castings made consist of a wide variety of automotive parts from crankcases to small unions; and in this plant a metallurgist is in

charge of the salvage operations. The following general instructions obtain in this plant:

"Aluminum-alloy castings in this plant are to be welded by the arc or oxy-acetylene process, using a cast welding rod of the same composition as the casting to be welded. In all castings except small and plain work and where the defect occurs on the edge and is small, the castings must be pre-heated before welding, and if very large they must be returned to the furnace until a uniform temperature is attained in the part before final cooling to room temperature. In the case of castings which are welded after machining, the machined face of the casting should be clamped to a plate of steel before welding so as to prevent warping."

"While soldering is not prohibited, as little soldering as possible should be done, and all repairs, wherever possible, should

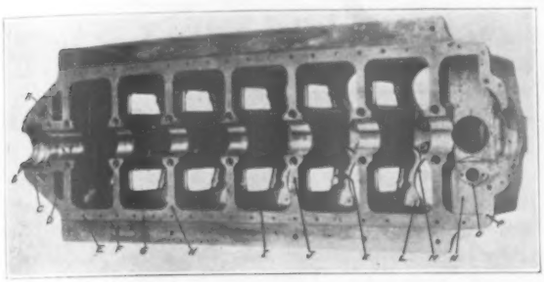


Figure 4

be made by welding. The following aluminum-alloy castings may be welded if they contain small foundry defects: Motor fan, switch board, switch-board central-shaft gear housing, motor-gear cover, chain-speed housing, carburetor, intake manifold, transmission case and cover, clutch case, steering-wheel spider, differential carrier, clutch brake-shoe bracket, crankcase oil filler, oil pan, and crankcase."

"In welding rough crankcases before machining, the arc or acetylene process may be used, and unless the defect to be repaired occurs on the edge and is small, the castings should be pre-heated before welding and then again heated so that a uniform temperature exists throughout the casting before cooling. No soldering is permitted on crankcases. It is often impossible to weld crankcases after machining because of warping which will occur, and small repairs on machined cases may be made by soldering. No soldering should be done on any part of a crankcase that is likely to be stressed in service. Defects occurring along the edges and on the cross members of crankcases can be welded without warping ensuing, and soldering should be avoided whenever possible."

Salvage of Liberty Aviation-Engine Castings:—The detailed salvage instructions drawn up by the Bureau of Aircraft Production during the war for the reclamation, inspection, and disposition of defective aluminum-alloy castings for the Liberty 12-cylinder aviation engine have been published by one of the writers in another place. For the purpose of the present paper, the general salvage of these castings and the particular instructions applying to the crankcase upper half will be given. The following statements are taken almost verbatim from the instructions:

The welding of all rough castings shall be carried out as follows: The entire casting shall be pre-heated to a temperature of approximately 260 degrees Cent., or to a temperature at which the casting will not ring when tapped with a hammer. Defects for repair must be thoroughly cleaned from any sand, oxide, or dirt, which would in any way interfere with the quality of the weld. The castings must be welded immediately after being removed from the pre-heating furnace. The welding stick used must be of approximately the same chemical composition as the casting itself. All welds, when finished, must have the same contour as the original casting. The so-called "burning-in" of castings, which show such defects as mis-runs and cracks, will not be allowed under any consideration. It will not be permissible to weld any cracks on aluminum-alloy castings unless definitely specified in detailed instructions. No welding will be allowed on any ribs of crankcases nor on the propeller end of the cases beyond No. 7 rib. Soldering of any kind will not be permitted on aluminum-alloy castings to be used on the Liberty aviation engine.

Small seepage leaks which are determined by the open-gasoline test may be treated by any of the following methods: (1) bakelite under pressure; (2) bakelite and aluminum powder; (3) boiled linseed oil under pressure, followed by baking; (4) accelerated ageing process; (5) annealing at not over 315 degrees Cent. The use of aluminum powder and sulphur will not be permitted for treating seepage leaks.

Small blowholes or gas pockets, which do not affect the strength of a casting, and which do not leak when treated by the open-gasoline test, shall be accepted as they are.

No castings for use on the Liberty aviation engine shall be treated or repaired in any way which will affect the appearance only.

Referring now to the detailed salvage and inspection instructions which applied to the crankcase upper half for this engine, the following remarks apply to Figs. 3, 4, and 5. The letters below refer to corresponding letters in the photographs.

As regards Fig. 3:

(A) Acceptance or rejection stamp shall be placed on this boss.

(B) Cracks caused by rough handling which run into crankcase flange screw hole are acceptable, provided crack does not extend beyond the hole.

(C) Castings showing porosity in this hole are acceptable, provided casting does not show oil leaks after assembly.

(D) Castings which show hole at this point drilled off center must be referred to the Production Engineering Department for disposition.

(E) Small cracks in ribs indicated, or small pieces broken from these ribs, may be repaired by trimming rib with file until defect is completely removed and no sharp corners remain. Defects of this nature shall not penetrate any rib more than ⅜ inch.

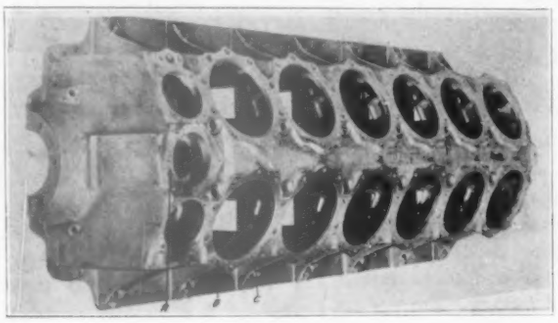


Figure 5

(F) Small cracks on this flange due to rough handling are acceptable, if ⅛-inch hole is drilled at end of crack. No welding of cracks of this nature is acceptable.

As applied to Fig. 4:

(A) Great care shall be taken to see that no castings are accepted showing shrinkage cracks under thrust-bearing retainer and propeller-hub bearing seat.

(B) Castings which show bearing felt-retainer inner wall not less than 1/16 inch are acceptable. Castings showing corners undercut, so that thickness of wall between corners and bolt holes at this point is not less than 1/16 inch thick, are acceptable.

(C) Castings which show holes drilled too near edge of flange are acceptable, providing no oil leaks occur after assembly.

(D) Castings showing leaks in No. 7 bearing by the open gasoline test indicate presence of blowholes under the bearing, and they shall be rejected.

(E) Cracks which penetrate the flange at this point and stop are acceptable as they are. No welding of this type of defect is permissible.

(F) Cracks which penetrate the flange at this point and stop are acceptable as they are. In case the crack does not run into a hole, then ⅛-inch hole shall be drilled at the end of the crack. No welding is permissible on this type of defect.

(G) Cracks which penetrate to a point not beyond the center line of holes are acceptable when a ⅛-inch hole is drilled at the end of the crack. No welding of defects of this kind is permissible.

(H) Castings showing porosity on surfaces are acceptable, provided they do not show oil leaks after assembly, or after having completed acceptance run. No shellac or other foreign material shall be used for stopping these leaks.

(I) Castings showing holes or mis-runs in webs indicated shall be rejected.

(J) Cracks in ribs indicated are not acceptable.

(K) Cracks at points indicated are not acceptable.

(L) Cracks in bosses are acceptable, provided they are not over ⅝-inch long. In case two cracks occur on the same boss and are not more than ⅛ inch apart, section between cracks shall be removed. A maximum of two cracks will be allowed to a single boss, and there shall not be more than one defective boss to a cylinder.

(M) Depressions in surface due to core fins which are not over 1/16-inch deep are acceptable. In every case, such depressions must be thoroughly cleaned.

(N) Sand holes in this face are acceptable, provided they do not leak on the open-gasoline test. In case small sand holes are found that do not leak, these holes may be repaired by the use of a ⅛-inch aluminum pipe plug. The plug must have at least three effective threads, and it must be screwed in tightly and cut off flush with each side of the casting. No peaning will be allowed. After being repaired, the caseing shall undergo an open-gasoline test for leaks.

(O) Sand holes on this face are acceptable, provided they are thoroughly cleaned and do not show oil leaks.

(P) Cracks which penetrate to this depth are acceptable, provided they run into bolt hole. Cracks which do not run into bolt hole or do not extend beyond the center line of the hole are acceptable after a ¼-inch hole is drilled through the flange at the end of the crack.

The following apply to Fig. 5:

(A) Castings showing porosity on this face are acceptable, provided no oil leaks occur after assembly.

(B) Castings which show porosity on the surface indicated are acceptable, provided no oil leaks occur after assembly.

(C) Castings showing small cracks at this point due to use of oversized stud are acceptable, provided they are less than ⅜-inch long and not more than one crack occurs on each cylinder pad.

Specifications similar to the above have also been drawn for the salvage of other castings for the Liberty aviation engine, including oil pans, camshaft housings, and pistons.

BRAZING CAST IRON PIPE LINES

By A. W. Young, Kalamazoo, Mich.

This is one of the latest fields to which acetylene work has been applied and the first question to be asked is, "What is the advantage over the old style of work?" In order to answer this, a comparison is necessary. The old style is plumbers work and the pipe ends overlap each other several inches, with an open space around to be calked and beaded. These joints sometimes get to leaking from various causes. The ground must be dug up, the babbitt melted out, and the job done over. Suppose a section of pipe is so badly broken that a new one is necessary, the ground is dug up and the old pipe removed. Now how to get in the new one. One end can be put in place all right, but the other end will be several inches too long, as they overlap each other. The ground will have to be dug up both ways far enough to raise the line high enough to spring the new section into place, some job.

In brazing pipe lines, there is no overlapping, and there are several things to be considered, in order to make a practical routine of work with as little loss of time as possible. In starting, the sections are laid on short plank over the trench and can be turned as the brazing progresses. Braze as many sections as can be handled by turning. This will vary according to length of pipe and its diameter. Lower into the trench and repeat the operation. The object is to do as little work as possible at the bottom of the trench. Lower this section and butt end it to the first. At this point enough ground should have been removed underneath this point of contact to allow for working purposes. In this brazing in the trench, some preliminary work was done, a description of which follows.

Get some square blocks of carbon, three inches wider than diameter of pipe and two inches thick. Have center turned out on lathe equal to the diameter of pipe. In center of the block, have a groove turned an inch wide and half inch deep (see fig. 1). Then saw the block across the center. These will make perfect under supports for the melted bronze. Heat up the pipe ends and wedge up the carbon block on the under side (fig. 2). Work down some flux through the groove and start melting the bronze rod. It will drop to the bottom of the groove. It is the opinion of the writer that a welder working on each side would

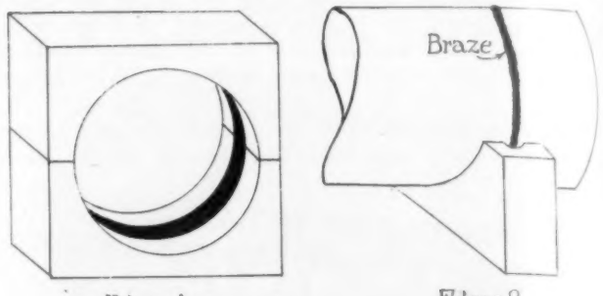


Figure 1 Figure 2

A Useful Device in Bronze Pipe Welding

do a better job, so that the heat would arise evenly on both sides and would prevent a chilling on one side which might make a defective job. If the bronze is kept in a liquid condition, without a break, to the top of the carbon on both sides, it is not likely that the work will be defective. The top half should be handled open without giving any trouble. The carbon blocks can be used a good many times if care is taken in removing them. This style of work should be as solid as a continuous iron pipe and the possibility of leakage practically done away with. Should a section become broken, an accident that rarely happens, it is only necessary to dig up the length of the section, melt off the bronze, and as there is no overlap of joints, another piece can be at once set in without disturbing the line at either end.

SEVENTEENTH ANNUAL EXHIBITION OF RAILWAY APPLIANCES

The National Railway Appliances Association has just terminated its seventeenth annual exhibition of railway appliances at the Coliseum, Chicago. The show started on March 9th and ran on through March 12th with great success. Those who attended proclaimed the show one of the best on record in the quality and number of exhibitions, the interesting way in which they were displayed, and the number of persons visiting it. Those of us who are interested in welding were not disappointed for there were interesting displays by Torchweld Equipment Co., Burdett Manufacturing Co., Air Reduction Sales Co., Oxweld Acetylene Co., Carbic Manufacturing Co., Alexander Milburn Co. and Mann Electric Welder Co. Westinghouse and General Electric were also represented but not specifically along welding lines. The other exhibits were of companies engaged in the construction, maintenance and operation of railways fields.

OBITUARY

Mr. H. W. L. Porth, Master Car Builder for Swift & Company, passed away in Chicago, March 2nd. The funeral was held in Kansas City on March 5th. Mr. Porth was born in Utica, Kansas, January 18th, 1889. He was graduated from the University of Missouri, School of Mines, in 1911. He came to Swift and Company as an engineer in the Mechanical Department at Kansas City. After two years there he was transferred to the Car Department, Chicago, as a Sub-Foreman. He was advanced to Assistant Master Car Builder on May 13th, 1919, at the death of Mr. J. E. Libby. Mr. Porth was a member of Temple Lodge No. 299, A. F. & A. M., Kappa Sigma and Tau Beta Pi Fraternities, American Welding Society, Western Railway Club, and many other technical organizations. He is survived by Mrs. Porth and one daughter.

Building a Good Welding Department

Faithful Record Keeping and Careful Observation Eliminate Duplication of Failures, and Lead to a Strong Department

At the March meeting of the Chicago Section of the American Welding Society which was held on the 6th of this month, some fifty members of the welding industry listened with considerable interest to a paper on the subject of "Autogenous Welding as Practiced by the Santa Fe Railroad." This paper was prepared by Mr. E. E. Chapman, Engineer of Tests on the Santa Fe Railroad, but, on account of the illness of his father, Mr. Chapman was unable to be present at the meeting. It was therefore read by Mr. Walter Bohnstengel, Asst. Engineer of Tests on the Santa Fe. Mr. H. A. Service, the Welding Supervisor of the Santa Fe, was present at the meeting and contributed generously to the interesting discussion which followed the reading of the main paper. Mr. Howard Lanning, a nationally known pioneer in the art of autogenous welding, was also in attendance and gave those present an extremely interesting account of the early experiments with welding and the early developments of the Welding Department.

The first point brought out in the paper of the evening was the fact that the railroad has a definitely organized system of welding instruction where the new welders are given a systematic training in the use of the torch and the arc. All of the welding on these lines is by this time fairly well standardized and all operators are held to a close accounting that the welding standards be rigidly maintained. It was realized many years ago that there are many dangers in the application of welding processes; therefore, records have been very carefully kept and data preserved and studied and the results handed back to the operators, with the net result that this railroad has made very gratifying progress in its application of welding with a minimum of failures and unfortunate accidents.

Data regarding the welding processes and their applications in railroad work are supplied to supervisors, foremen and operators in the form of a large folio of blue prints and instruction sheets. This book gives especial attention to the subject of boiler welding, giving careful instructions in procedure and pointing out the things to be avoided. It also carries a very extensive list of "Don'ts for Welders." These "Don'ts" cover the handling of equipment, welding procedure and a variety of its operations. A good many of them are inserted in the list as a result of their own experience and a good many as the result of experience of others which have come to the attention of the Welding Department. General instructions for both gas and electric welding are included in the folio and explain the fundamental principles of good work by each process. These are followed by a series of safety suggestions, always an important subject whether the welding department be large or small.

It developed, from the reading of the paper, that a great deal of the progress made in this department was due to the careful supervision exercised over it by the Testing Department. As new problems come up or new suggestions are made, decision as to whether the weld should or should not be made was usually arrived at after careful tests had been made on a series of specimens. A brief description was given of tests made on truck frames, boiler steel, thermit welds, flues, fire box cracks, steel rails, tires, locomotive frames, crossing rails, side frames and couplers. Tests were also made to determine the importance of variations in gas pressure both as regards the efficiency of the weld and cost of making it. Tests were made of various kinds of equipment and very often showed advantages in one type of apparatus would be balanced by disadvantages which were not common to other types. Similar tests were made of various grades of welding wire for different classes of work; of the effect of cutting different kinds of metal. Each one of the tests mentioned above represented a long period of investigation covered by very careful reports, consequently only a brief description of each was possible. The results of the tests are included in the instructions given to the operators through the folio on welding.

Table One shows the results of the tests made to determine the efficiency of the welders themselves, each operator being required to weld a test piece at regular intervals and receiving full information regarding the result of the test. Tests were also made of the actual work done in the shops. This table is prepared to show the value of years of experience and indicates very clearly that years of service usually improves the quality of the work turned out. Tables Two and Three are compiled from data regarding tests on welding specimens.

In the discussion which followed the reading of the paper, Mr. Service pointed out that there is quite a variety of welding jobs which can be done satisfactorily provided the pieces are annealed after welding; but that regardless of the quality of the welding job a failure in the piece is almost certain if annealing is not provided after the welding is finished. This is also true of a great many of the cutting jobs. He estimated that for one of their mechanically operated cutting torches there was a list of 400 operations provided. In many of these operations the pieces were heated to 700 degrees previcus to cutting, and annealed after the cutting was completed.

Table I

Years Service as Welder	Welded Specimens Tested Gas	Electric		a. Efficiency of Weld—percent Gas	Electric
Less than One	195	147		75.8	90.6
One	93	81		89.2	93.2
Two	177	131		85.8	92.9
Three	78	72		84.4	95.2
Four	47	10		90.6	96.9
Five	27	....		96.7	.....
Six	4	6		98.3	101.0
Seven	3	9		74.6	94.9
Eight	16	....		82.4	.....
Nine	7	....		89.6	.....
Total	647	456	Ave.	86.7	95.0

Table II

Shops	Welded Specimens Tested Gas	Elec.	b. Specimens broken outside of weld percent Gas	Elec.	a. Efficiency of Specimen broken in Weld—percent Gas. Min.	Ave.	Elec. Min.	Ave.
Topeka, Kansas	29	46	24	24	77	101	75	96
Albuquerque, N. Mex.	63	32	62	53	57	99	75	101
San Bernardino, Calif.	31	34	45	38	84	104	88	104
Cleburne, Texas	16	9	63	33	68	90	83	98
Total	139	121	....	....	....	....	....	....
Minimum	....	....	....	....	57	....	75	....
Average	....	....	50	37	....	98	....	99
Winslow, Ariz.	9	9	56	33	101	108	98	105
Amarillo, Texas	8	8	75	75	103	103	78	89
Newton, Kansas	22	32	46	22	80	99	88	100
Shopton, Iowa	25	22	52	36	83	98	79	103
Total	64	71	....	....	....	....	....	....

Minimum	....	....	....	....	....	80	....	78	....
Average	....	....	53	34	....	100	....	101	

Table III

		1923		1924		
	Welded AT&SF	Failed AT&SF,	Others	Welded AT&SF	Failed AT&SF,	Others
Truck Frames	623	5	18	871	7	26
d. Truck Bolsters	674	5	8	2771	5	24
Body Bolsters	226	0	2	218	1	0
d. Side Frames	517	10	31	1884	5	51
Total Castings	2040	20	59	5744	18	101
e. In Service Percent	96.1	....	....	97.9	....	....
e. Out of Service Percent	....	1.0	2.9	....	0.3	1.8

a.—These efficiencies are values based on a tensile strength of 52,000 lbs. per sq. in., the minimum value allowed in specification for fire box steel.

b.—This column also includes welds, which showed 60,000 lbs. per sq. in., tensile strength.

c.—Of the failed casting 85% had no marks or were marked as welded on other railroads.

d.—Approximately 60% of the truck bolsters were built up on account of being worn, and 40% of the truck side frames were welded for the same reason.

e.—The percentage of welds in service and out of service is based on the number of welds made during that year and not on the total number of welds in service at that time.

BRONZE WELDING FOR LOCOMOTIVE FRAMES

BY J. H. CHANCEY

SEVERAL inquiries having been made by those interested in the subject of bronze-welding for locomotive frames, I take pleasure in giving the welding field my views and experience on the subject. Inasmuch as we now have on the Georgia Railroad frames welded by the Tobin Bronze process, which have been in continuous freight and passenger service from three to nine months, this should place me in position to say something for this particular method.

When the subject of welding frames with bronze method was first suggested by a demonstrator, I am frank to admit that I was rather reluctant in attempting it. However, after being assured that is was possible to weld the bronze to steel or iron sufficiently so that the bronze would break before turning loose its welded surface, this method of welding locomotive frames was started on the Georgia Railroad. As stated above, we have nine engines in service with frames so welded, ranging from three to nine months service, with 100 per cent success.

In relating my experience to quite a few, such a lack of confidence and disapproval was manifested that I decided to test the process out in our own way, and authority was given for this test to be made. The results of those tests are given below for the benefit of those interested.

Test No. 1

Two pieces of Tennessee Bloom Iron, 4¼ x 4¼"—12" long, were welded together by the acetylene process, using ¼" Tobin Bronze filler. This test piece was then placed in wheel press in position to allow press ram to bear directly against center of weld. Test piece started bending at 75 tons pressure. Pressure released at 100 tons and reversed and reapplied. Started bending at approximately 100 tons, bent 1¼" out of line and cracked one-half way through center of weld at 125 tons pressure.

Test No. 2

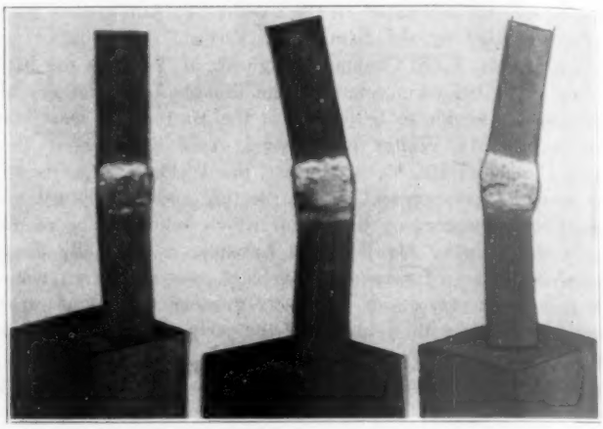
Two (2) pieces same grade and same dimensions, welded by acetylene process with ¼" Norway Iron filler. Tested in same manner. Started bending at approximately 70 tons pressure; bent 2" out of line at 100 tons. Pressure released at 100 tons, and on reverse pressure started bending at 95 tons; bent 1½" out of line and cracked one-half way through center of weld at 110 tons pressure.

Test No. 3

Two (2) pieces same grade and same dimensions, welded by acetylene process with a patented steel ¼" filler. Tested in same manner. Started bending at approximately 80 tons pressure, bent 1½" out of center and broke clear through center of weld at 100 tons pressure.

Test No. 4

Two (2) pieces same grade and same dimensions, welded by electric process with $\frac{3}{16}$" filler. Tested in same manner. Started bending at 85 tons pressure, bent 1¼" out of line and broke in two pieces at 100 tons pressure.



Testing Bronze Welded Steel Bars

From these tests the reader will note that the bronzeweld surpassed all others by a margin of fifteen tons, and the writer is thoroughly convinced the bronze weld for locomotive frames is superior to any autogenuous weld with other material I have thus far made. Furthermore, my exeprience has shown that the bronze weld can be made with less expense than any other autogenous weld.

In making these test welds, full access was afforded for test of expansion and contraction, and it was found that the bronze weld contracted only $\frac{3}{4}$" after entirely cooling off. Therefore, the bronze weld elminates the frame problems we are confronted with, where it is often out of the question to get the required expansion, other than by electric welding. Still another feature in favor of the bronze weld is that it can be completed in approximately one half the time required in using any other filler, which necessarily results in quite a saving in time and material.

In summing up my remarks, I make these suggestions: Cut your "V" to sufficient angle to give necessary torch play, taking pains, of course, not to get them too large, using as small a "V" as possible. You get a quicker, better job with less expense for material, labor, etc. Chip your welding surface of frame as clean as possible, and last, but not least, get the best obtainable operators on the job and your success is certain.

In support of my above remarks, on October 15th, 1924, we welded a top rail in front of a main driver without removing anything, and allowed for no expansion. This job was completed in thirty minutes after the torch was applied, using No. 10 tips of frame 4 x 5". The entire cost of this operation, including labor and material amounted to approximately ten dollars.

LOW PRESSURE TORCH ADDED TO MILBURN LINE

The Alexander Milburn Company, Baltimore, Maryland, manufacturers of oxy-acetylene welding and cutting equipment have recently added to their line a new torch which is built for use wherever low pressure acetylene generators are operated. This new number has been shown at recent conventions and the makers consider that it is going to be well received for work for which their high pressure torches are not adapted.

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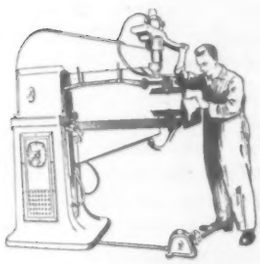

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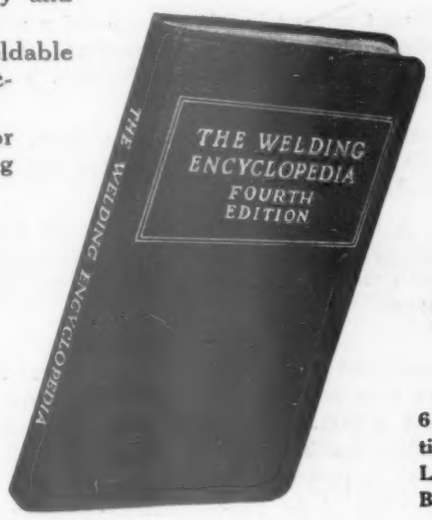

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HARRIS COMPANY EXPANDING

Mr. Wm. H. Joyce who was associated with the Davis-Bournonville Company for sixteen years and has been spending the past two years on the Pacific coast has recently joined the organization of the Harris Calorific Company, Cleveland, Ohio. This company has recently been making changes in its line of welding and cutting equipment which is sold directly to manufacturers, also representatives and jobbers. The Harris plant is now undergoing complete overhauling and reorganization and plans are being made to provide additional floor space for new projects in another building.

News of the Welding Trade

Libby Welding Company has just completed a new brick and steel building to house their welding business. This plant is located at 115 Frelinghuysen Avenue, Newark, N. J.

Mr. M. Keith Dunham, president of the Keith Dunham Company of Chicago, recently left the United States for an extended business trip in Europe.

The Chicago office of the Gibb Welding Machines Company has recently moved back to its former address 122 South Michigan Avenue.

The warehouse and general office of the Central Steel & Wire Company have recently moved from 137 North Peoria Street, Chicago, to 4545 South Western Avenue, Chicago. The new telephone number is Lafayette 8500.

The Chicago office of the Burke Electric Company is now located in the new Strauss Bldg. on Michigan Avenue, Room 1127. Mr. M. E. Standish is in charge.

It is reported that Mr. Heller, of the International Oxygen Company, Newark, N. J., has just been enjoying a short European trip.

Members of the Gas Products Association are rejoicing in the recovery of two of its members who have been off duty for considerable period this winter on account of illness. Mr. M. L. Goodrich, of Swift & Company, president of the association, was absent for several weeks during which he was obliged to undergo a serious operation. He was greatly missed at the recent convention of the association and at the regular meetings of this group throughout the winter. His friends in the trade will be very glad to know that he has enjoyed a complete recovery and is able to resume all of the duties which have had his painstaking attention during the past several years. The association also missed Mr. C. T. Allen. Mr. Allen has also recovered himself and is on the job as usual.

The Dombroski Brothers Welding Company of Scranton, Pa. recently moved their plant from 1028 South Wyoming Avenue to 201 West Elm Street.

It is reported that the F. S. Dennis Welding Company of 637 North Cass Street, Chicago, Ill., are acting as distributors in the Chicago district for the Westinghouse Welders. Mr. Dennis is well known in the district as one of the most experienced and successful welders in the city.

Mr. W. A. Slack, president of the Torchweld Equipment Company, has just returned to Chicago after an extended trip through the East.

Mr. H. A. Austin formerly president of the National Oxygen Company, Chicago, and for a long time chairman of the Chicago section of the American Welding Society, has been severely ill during the past winter. It is reported that he has recovered sufficiently to resume his present duties as president of a local insurance company.

Mr. W. M. Bastable, Wilson Welder & Metals Company, has been enjoying some delightful winter weather in Cuba and is expected to return very shortly.

Mr. Allan Renton, of the Hawaiian Gas Company, Honolulu, is making a trip through the United States visiting gas plants and large welding installations. He spent a few days of the week of March 2nd in Chicago.

Mr. John Brandt and Mr. Walter Brandt, of the Indiana Oxygen Company, and Mr. Foran, president of the Kansas City Oxygen Company, were guests of the Gas Products Association on Tuesday, March 10th.

The Gibb Welding Machines Company of Bay City, Mich., announce the appointment of the Welding Service & Sales Company, Donovan Bldg., Detroit, Mich., Mr. T. M. Butler, Mgr., as agents in the Detroit territory for their line of arc, spot and seam welding machines.

The Weil-McLain Co., Michigan City, Ind., is building a foundry 120x210 ft. and also a steel constructed warehouse 100x240 ft. The company manufacture the Weil-McLain scientific combustion hot water and steam boilers.

The Gas Products Association has distributed to its members reprints of an address by the Hon. Herbert Hoover, secretary of commerce, delivered before the National Distribution Conference, entitled, "A Problem of Distribution," dealing with the possibilities of reducing the between the farmer and manufacturing producers on one side and the consumers on the other side.

The Carbide and Carbon Chemical Corporation, the Linde Air Products Company and the General Electric Company will be represented at the Chemical Equipment Exposition, which will be held in the City Armory, Providence, R. I., June 22nd to 27th.

The Northern Engineering Works, Detroit, Mich., manufacturers of cranes, hoists, etc., on the occasion of election of officers for 1925 announce satisfactory business for the past year and extensive preparations for a very active current year.

It is reported that the Copper Welding Corporation, Pittsburgh, is planning to remodel a one story foundry located at 3009 Pulaski Street, Lawrenceville, Pa., and to establish a new plant there.

The Spring Meeting Excursions announced for the meeting of the A. S. M. E. in Milwaukee, May 18th to 21st includes trips to the Sewage Disposal Plant, Palmolive Company, Phoenix Hosiery Company, Allis-Chalmers Mfg. Co., Elines, Inc., Powdered Fuel Plant, Robert A. Johnston Company, Kearney & Trecker Company, Vilter Mfg. Company, Riverside Pumping Station, Falk Corporation, Lake Side Power Station, and Nordberg Mfg. Company.

Announcement has been received from the Boston Section of the American Welding Society that the society will hold

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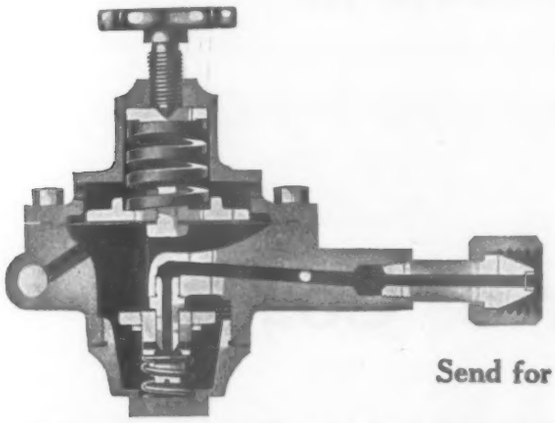

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its annual fall meeting this year in Boston from October 27th to and including October 30th, in the buildings of the Massachusetts Institute of Technology.

The Electric Arc Cutting and Welding Company of Newark, New Jersey, has announced the opening of its new branch office at Syracuse, New York. This office will be completely equipped to handle all sales and distribution of welding machines and supplies for the entire state, exclusive of the metropolitan district. Mr. Wm. P. McCarthy will be in charge of this branch.

Mr. K. L. Brackett, Pacific Coast District Manager of the Air Reduction Sales Company, has resigned and Asst. District Manager, Mr. G. J. Williams, has been made Acting District Manager for that division.

A new type of synchronous motor has been developed by the General Electric Co. for direct drive of slow speed reciprocating compressors. This motor, bearing the designation TS, is being built in more than 300 standard ratings larger than 20 hp. at 60-cycles synchronous speeds between 72 and 450 r.p.m.

The Standard Sheet Metal Works, 1485 Thirtieth Street, Milwaukee, specializing in the fabrication of sheet metal buildings, portable houses, garages, etc., will effect an increase of 75 to 100 per cent in capacity by the immediate construction of a one-story brick and concrete extension, 80x120 ft., with a second floor, 30x80 ft. Bids are being taken until March 21 by Erich G. Schroeder, architect and engineer, 405 Broadway, local. John G. Mattes is president.

The Annual Get-together Dinner of the Air Reduction Sales Company, was held at the Yale Club, New York, February 5th. District Managers and Representatives numbering about 150 attended and termed the dinner a great success. This has been a yearly occurrence since 1918 when the first one was held and only a few attended. The increasing number each year reflects the rapid growth of the industry.

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Back Copies of The Welding Engineer Wanted—If you have a complete or almost complete file of *The Welding Engineer*, please write, giving price and details. Address, 48, care The Welding Engineer.

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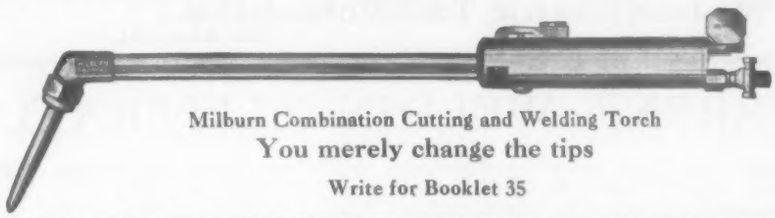

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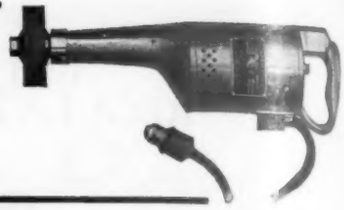

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CURRENT WELDING LITERATURE

TWIN-POLE ARC WELDER.—The Todd Specialties Company, 25 Broadway, New York, has issued a folder describing briefly the Todd twin-pole arc welder arranged for portable and stationary use. Twelve different types of this welder are available, including the portable unit mounted on a Fordson tractor. This and other gasoline-drive types are most practicable for field work and in the field can be used not only for welding but the power available can also be applied to the operation of drills, grinders, chippers, calking tools and lighting. This power feature does not in any way interfere with the welding feature.

SAFE HANDLING IN USE OF CUTTING GASES.—Paper read before the American Welding Society, Chicago Section, by G. O. Carter, Linde Air Products Company, New York. This paper treats with the fuel gases and oxygen used in welding and cutting. The approved practices for generating and handling fuel gases have been set up by the regulations of the National Board of Fire Underwriters. How oxygen cylinders should be received and stored. Call oxygen by its right name. Oxygen is not air. Store in safe places. Oxygen for tap holes. Hazards of furnace work. Pipe lines for oxygen supply. Oxygen manifolds. Oxygen pipe.—January 2, 1925.

FUNDAMENTALS OF OXY-ACETYLENE WELDING AND CUTTING IN THE RAILROAD SHOP, by W. H. Ludington.—This is a continuation of an article which ran in the February issue of the Acetylene Journal. It deals with the subject as outlined in the heading. An outline of the tremendous field for small welding jobs includes bolsters, body stiffeners, side and center sills, passenger car face plates, passenger car diaphragms, transoms, truck oil boxes, coats, stakes, braces, draft castings and truck sides. It also deals with reclamation jobs and operations which might not prove economical. Cutting is also taken up.—Acetylene Journal, March, 1925.

ELECTRIC ARC WELDING APPLIED TO SHIP REPAIRING, by A. G. Bissell.—Give many applications of electric arc welding in the field of steel ship repairing. Common repair jobs include installation of patch plates, "Blanking-off," holes in bulk heads, deck and shell plates. Arc welding adapted to underwater body repairs on bronze propellers, steel stern frame and rudders. Discussion of welding fair-waters to bearing castings. Seams on underwater bodies usually sealed with the arc on the caulking edge. Oil plates made reusable. Fittings, pad eyes and deck clips are usually attached to decks and bulkheads by welding. Ingenious use of arc welding in fastening ice guards. Electric arc may be used for welding copper brass or bronze.—Marine Engineering and Shipping Age, March, 1925.

OXY-ACETYLENE WELDING FOR THE CONTRACTOR.—The oxy-acetylene torch proves an indispensable tool for the construction, repair and maintenance of equipment, and as a handy construction tool on the job. Cast iron columns easily cut for removal. Bridge pipe made from rolled sheet. Inside frames for concrete pipes are made by welding. Blow holes are filled in, tunnel linings welded, tubs for floating building materials to the job.—Oxy-Acetylene Tips, December, 1924.

OXY-ACETYLENE PORTABLE FIRE CLAY TESTING FURNACE, by Air Reduction Sales Company.—High temperature produced by oxy-acetylene flame about 6300 degrees F. is useful for testing the temperature resistance of refractory materials such as pottery and fire clay.—Acetylene Journal, March, 1925.

OXY-ACETYLENE WELDING IN THE SHIRES.—The Rural Industries Board has developed the oxy-acetylene process for the country smith and farrier. They have shown how this process may be used for welding broken crankshafts, broken car wheel tires, binder cranks, damaged cylinders, and lawn mowers. Great growth in this branch of the industry seen.—Industrial Gasses, December, 1924.

WELDING AND CUTTING AT THE DECATUR, ILLINOIS SHOPS OF THE WABASH RAILROAD, by James S. Heaton.—A very interesting article dealing with the supervision of welding and welding operations. The Wabash is unique in that it uses all classes of autogenous welding, electric, acetylene and thermit and consequently any cutter or welder employed can do work for any craft within the shop. The various welding jobs which come to this shop are interestingly discussed and among them are cutting stay bolts, welding superheater units, welding rack housings and a discussion of cylinder preheating equipment. This article is to be continued. —Acetylene Journal, March, 1925.

DEMOLITION OF OLD BROXBOURNE-RAYDON RAILROAD BRIDGE.—The old bridge was built by Mr. Geo. Bidder in 1840. The new bridge was erected upon rollers and rolled into place when the old one was cut away with the oxy-acetylene process. Acetylene flare lights were used as the work was done at night in order to do away with railroad tie-ups.—Industrial Gasses, December, 1924.

OXY-ACETYLENE TIPS—Service Leads to Saving of Oxygen, Time, Money; the call of a service man will often uncover many economical welding applications in the plant that has not had a thorough survey.—The Systematic Shop Keeps The Business; the wise manager assures success by always being a few steps ahead of competition.—Blowpipes Build Leakproof Tanks; fabrication of the best storage tanks becomes a simple operation when the oxy-acetylene process is used.—A Pipe Line Built for Permanency; how a public service company insured against leaks and radiation losses in their steam heating line by welding and insulating properly.—Time Saved In Fabricating Plant Appliances; paper mill makes jacketed pipes in 14½ hours less time than had previously been required.—Fabricated by Oxywelding; welding and cutting blowpipes have become indispensable to producer and user alike in the manufacture, maintenance and repair of refrigeration equipment.—A Centralized Welding Department, how a large plant gets the maximum benefits out of its oxy-acetylene operations.—Electrotypers and Engravers Use Blowpipe; copper and steel face plates repaired and altered by welding.—A Pipe Line With Unusual Features; 63-inch diam. made of $\frac{5}{16}$-inch plate, carries air at 4 lbs. pressure for over 3,000 ft.—When is Scrap Material Really Scrap?—Again—the Leak Proof Pipe Joint. —March, 1925.

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20-lb.	100 cu. ft.	130.00
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100-lb.	500 cu. ft.	340.00
200-lb.	1000 cu. ft.	600.00

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These Generators are Automatic, equipped with the CELEBRATED SUPERIOR FEED, with either WEIGHT DRIVEN—or SPRING DRIVEN MOTOR.

GENERATES GAS FOR ABOUT $1.20 PER 100 CU. FT.

CAST IRON RODS: All sizes, cast round or square, high in silicon, give a nice soft weld.

(WRITE FOR COMPLETE CATALOG.)
(Agents wanted in unoccupied territory)

WE REPAIR ALL MAKES OF TORCHES, REGULATORS AND GAUGES

Welding Carbon Products

National Round Welding Carbons
National Welding Carbon Plates
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Our welding carbon products are designed especially for welding operations

National Carbon Company, Inc.
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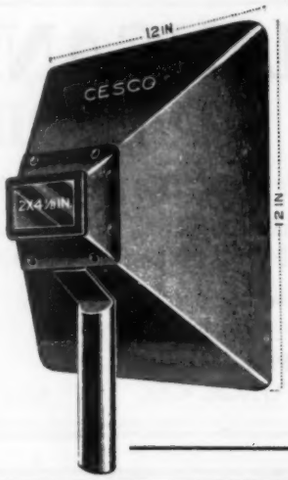

CESCO HAND SHIELD
Style M.

Made of black fibre, 12x12 inches, formed so as to allow a depth of 4 inches which amply covers the operator's face.

Weighs only 12 ounces complete with "ESSENTIALITE" welding glass, the Standard of America.

Manufactured By
CHICAGO EYE SHIELD CO.
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OXYGEN, ACETYLENE AND HYDROGEN
For Cutting, Welding, Etc.

Quick shipment and low prices on oxygen, acetylene, hydrogen, cylinders, valves, Rego welding and cutting torches, regulators, welding wire, cast iron and aluminum rods, fluxes, plain and armored rubber hose, asbestos pads and paper, goggles, etc. All equipment fully guaranteed.

We are American pioneer manufacturers of oxygen. Write for catalog and prices.

International Oxygen Company
Main Offices: NEWARK, N. J.
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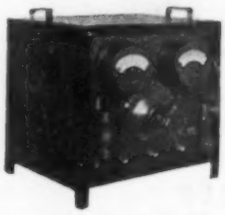
ARC WELDING EQUIPMENT
TRANSFORMERS, MOTOR & GASOLINE ENGINE GENERATOR SETS
WELDING ACCESSORIES
ALLAN MANUFACTURING & WELDING CO.
724 Washington St., Buffalo, N. Y.

DRILL—GRIND—POLISH
STRAND
FLEXIBLE SHAFT EQUIPMENTS
Several Sizes
N. A. STRAND & CO.
5001 N. Lincoln St. CHICAGO

QUASI-ARC SYSTEM



We Manufacture:
A. C. & D. C. Welding Sets
Also Weldtrodes for
Mild Steel
High Carbon
Manganese
Cast Iron
Gives Machinable Weld

L. W. 110 V. WELDER

QUASI-ARC WELDTRODE CO., INC.
Peekskill, New York

IMPERIAL WELDING AND CUTTING EQUIPMENT
OXY-ACETYLENE PROCESS

A new mixing principle, a regulator that accurately controls gases, the greatest working range ever covered by ONE torch —are exclusive IMPERIAL features. Write for catalog.
Imperial Brass Mfg. Co., 517 S. Racine Ave., Chicago

WELDING ROD HOLDERS
For the Oxy Acetylene Welder. Price $1.00
ALL STEEL WIRE BRUSHES
35c Each, 4 for $1.00
Write for Dealers' Prices
C. SORENSEN, 18 E. 16th ST., CHICAGO, ILL.

Announcing:--
Stoody's Self Hardening Alloy Steel Welding Rod

Deposits a hard, tough, non-machinable surface having the highest abrasive resistance; maximum wearing qualities.

Does not require heat treating
Can be used with both Electric and Acetylene
Easy to apply in any position
Will not blister or boil

Jobbers Attention
This merits your further investigation.

STOODY CO. Whittier, Cal.
Makers of Stoody Electrode Holders.
A. J. WILSON CO., INC., 120 Liberty St., New York City, N. Y.
Eastern agent for Stoody Electrode Holders.

For Gases Charged at High Pressures
WM. WHARTON, JR. & CO., INC.
30 Church St., New York, N. Y.

W
WESTINGHOUSE ELECTRIC

Westinghouse

manufactures complete arc welding equipment for all welding and cutting purposes. Write for Leaflet 1719 which describes this equipment in detail.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

Carbic

THE CARBIC LOW
PRESSURE ACETYLENE GENERATOR

THE CARBIC CAKE—
COMPRESSED CALCIUM CARBIDE

SAFER, CHEAPER, PURER ACETYLENE

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NEW ORLEANS, LA.
Woodward, Wight & Co.

Warehouses or representatives in all principal cities

Carbic Cakes save money, time and patience, and yield a purer gas.

Booklet "Alternarc" sent if you read this

EXCERPTS FROM VOLUNTARY LETTERS FROM SOME OF OUR USERS.

W. D. Baugh, of the *Greenwood Welding Works, Greenwood, Miss.*—"Propaganda put out by all Acetylene supply men (Salesmen) about the glaring (?) faults of arc welding generally, has kept me out of the market for two years, and I only decided to buy when I saw your "AD" in *The Welding Engineer*, that motor blocks could be welded on the car, etc., and I bought it for that purpose alone, although I am happy to say that my machine is handling 50% of the work I used to do with gas, and the cost is too little to add on to the price. As buying your machine has really brought me real and lasting property, I am more than glad to do all I can to further your interests."

Mr. L. A. Hacker, of 529 *N. Main St., Vernon, Texas.*—"I pay $5.00 minimum power bill with the installation of your machine, and the bill runs from $4.50 to $8.00 per month at my shop, and I do all the work possible with this machine. I do more than ⅔ of the welding with my electrical machine, and if it were not for cutting with gas, I could almost dispense with my old tools. Of course, I weld aluminum with gas, also, but most of my work is done with the electric, and the bills average under $6.00 a month. My bills for gas used to run from $60.00 to $80.00 a month, and the electric machine has reduced it to that amount. (After using our machine eighteen months, he has made enough money to build a brick building, and he voluntarily states it is practically due to the advent of our apparatus.) Also, your machine is the best ever, and I would not part with it under any circumstances."

Mr. Haas, of the *Warren Boiler & Welding Co., Warren, Pa.*, was in our shop to see what we were doing and he said: "I can't see that I am anywhere near realizing the full possibilities on my work, but, based on the work already done, if I could not get another machine, I would not part with this one for several thousand dollars."

Mr. Scozzafava, of the *Gouverneur Welding Co., Gouverneur, N. Y.*—"I would not take $2,000 for my Alternarc welder."

Mr. Rabold, of the *Metals Welding Co., Wilkinsburg, Pa.*—"Enclosed, please find check for $50.00 as a final payment for Electric Arc Welder as per contract. We take this opportunity to thank you for the courtesy extended, and wish to state that we are very well pleased with our machine thus far. Its usefulness becomes more apparent every day, and the results we are able to obtain are very satisfactory."

Mr. Talkowsky, *Manhattan Welding Co., 11 Sixteenth Avenue, Newark, N. J.*, says: "I will never touch the gas torch again. I can get just as good results by preheating and using electric where preheating is necessary and for most of the jobs there is no preheating."

Mr. R. E. Greenway, *Electra, Texas*, writes: "I have had a chance to turn out several jobs that have been highly superior to an Acetylene and the time and heat cost has been so much in favor of the electric arc, that there is no comparison. It looks to me as if the electric bill of $6.00 or $8.00 would replace the gas bill, for the same work, of $60.00 or $80.00 a month."

Libby Welding Co., of 115 *Frelinghuysen Avenue, Newark, N. J.*, who have two of our machines and have just built a new brick and steel building of their own, write as follows: "With reference to your request as to the proper welding equipment for an up-to-date welding shop to meet the demands of general welding, would like to say that with the exception of brass, copper and aluminum, we at all times use your Alternarc electric welding machines.

"We find that the electric welding process is by far the best and most efficient; also speedier and practically inexpensive. In other words, a job done electrically, the cost to the job welder is practically the man's salary, while the acetylene welding is an actual expense from the beginning of the operation to the finish, which, even on a small job, totals into dollars instead of cents. For bronze, aluminum or brass, or for cutting, gas must be considered, but from an expensive standpoint, we even have to fall back on the electric welding machine for cutting cast iron.

"We can cheerfully say that the Electric Arc Cutting and Welding machines are the peer of any other welding apparatus on the market."

Mr. E. R. Randall, *Lewiston Welding Co., Lewiston, Maine.*—"My machine has never given me one minute's trouble since I purchased it March 21, 1922."

WHAT OUR CUSTOMERS TELL OUR PROSPECTS UPON INQUIRY

Greenwood, Miss., December 19, 1923.

"Regard 'ALTERNARC' splendid investment. You can get machine for any alternating and almost any direct current required. We get better results on alternating than any direct current machine we ever saw. No upkeep except few ounces grease for blower shaft every three months. Our machine paid for itself three times in eight months. It will do everything claimed by the manufacturers and do it for one-twentieth the cost of gas welding. Please pardon delay answering. Writer been out of the city."

GREENWOOD WELDING WORKS,
W. D. Baugh.

Dunn, N. C., December 20, 1923.

"In reply to your favor of the 13th regarding our Electric Welding Machine, beg to advise that we are indeed well pleased with this machine. It has given us perfect satisfaction. We have this machine on a flat rate of $10.00 per month, using alternating current. We use two hundred and twenty volts, however, the machine is equipped to use practically any voltage from one hundred to two hundred and twenty volts. The machine is certainly fine on welding tanks, boiler patches, tubes, automobile frames and other kindred work. We have this machine installed in our jobbing department and do considerable automobile work. We receive a price of $10.00 for welding automobile frames, and usually the first automobile job after the first of the month pays the power bill. The machine also saves us considerable money in welding stack sheets and boiler tubes, as we have numerous short pieces of these continuously on hand. We have also welded cold rolled shaft up to six inches and locomotive frames with perfect results. Our machine has given us perfect satisfaction, and we would not be without it.

"Trusting this information will be of value to you, we are with best wishes,

"Yours very truly,
"THE JOHN A. MCKAY MANUFACTURING CO."

Electric Arc Cutting & Welding Co. 152-6 Jelliff Ave., Newark, N.J.

"Alternac" Portable Electric Welding Equipment & "New-Arc" Electrodes & Supplies